DOCUMENT RESUME

ED 055 611 LI 003 165

AUTHOR	Mayeda, Tadashi A.
TITLE	Information in Health Care.
INSTITUTION	Interuniversity Communications Council (EDUCOM), Boston, Mass.
SPONS AGENCY	National Library of Medicine (DHEW), Bethesda, Md.
REPORT NO	RM-1269
PUB DATE	Jan 69
NOTE	84p.; (20 References)
AVAILABLE FROM	EDUCOM, P.O. Box 364, Rosedale Rd., Princeton, New Jersey 08540 (Members $2.00, Non-members $4.00)
EDRS PRICE	MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS	*Health Services; *Information Needs; Information Services; *Information Systems; Information Utilization; *Medicine; *Physicians
IDENTIFIERS	*Medical Information Systems

ABSTRACT

The report stresses the fact that while there is unity in the continuum of medicine, information in health care is markedly different from information in medical education and research. This difference is described as an anomaly in that it appears to deviate in excess of normal variation from needs common to research and education. In substance, the report states that information provided to researchers and educators can be anticipated to a large degree and that this lead time can be used to advantage by publishers, authors, and lecturers. In problems of medical care, the lead time is lacking and the information system must react to inquires after-the-fact. In essence what was good for education and research is not as effective in health care and collateral resources are called in to fill the void. This report calls for an upgrading of directories, compendia, and guides to enable physicians to locate and use information in a severly time-constrained problem environment. It implies that there should be some innovative re-grouping of all types and sources of information to allow the clinician to gain as much from a national network as do the researcher and educator. (Author)

"PERMISSION TO REPRODUCE THIS COPYRIGHTED MATERIAL BY MICROFICHE ONLY HAS BEEN GRANTED BY

EDUCOM

TO ERIC AND ORGANIZATIONS OPERATING UNDER AGREEMENTS WITH THE U.S. OFFICE OF EDUCATION. FURTHER REPRODUCTION OUTSIDE THE ERIC SYSTEM REQUIRES PERMISSION OF THE COPYRIGHT OWNER."

EDUCOM

RESEARCH MEMORANDUM

Biomedical Communications Project

ED0 55611

INFORMATION IN HEALTH CARE

RM-1269

January 1969

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

Tadashi A. Mayeda

Prepared for the
National Library of Medicine
Bethesda, Maryland

Under contract with the
University of Pittsburgh
NIH Contract No. PH-43-67-1152

LI 003 165

1

100 CHARLES RIVER PLAZA BOSTON, MASS. 02114 617-227-1805

ED055611

INFORMATION IN HEALTH CARE

RM-1269

January 1969

Tadashi A. Mayeda

Research Associate

EDUCOM

Interuniversity Communications Council (EDUCOM), Boston, Mass

Prepared for the

National Library of Medicine

Bethesda, Maryland

Under contract with the

University of Pittsburgh

NIH Contract No. PH-43-67-1152

LI 003 165

The research upon which this publication was based was performed pursuant to contract No. PH-43-67-1152 with the National Library of Medicine, Public Health Service, U.S. Department of Health, Education, and Welfare.

TABLE OF CONTENTS

Page

List of Illustrations.....iv

Preface..... v

Abstract.....vi

Abstract..... 1

I. Introduction..... 5

II. Areas of Interest in Health Care.....16

III. Applications of Information.....26

IV. Types of Information.....32

V. Information Handling.....38

VI. Individuals and Organizations.....39

1. Physician.....43

2. The Medical Care Process.....52

3. The Organization.....58

VII. Health Care Requirements for Information Handling.....66

VIII. BCN Components for Information Handling.....74

IX. Summary.....

LIST OF ILLUSTRATIONS

Figure		Page
1.	Key Areas of Interest in Medicine & Comprehensive Health	6
2.	Four Types of Information	28
3.	Examples of Information Handling	33
4.	Flow of Processed Information	35
5.	Relationship of Specialties to the Health Care Process	44
6.	The Medical Care Process	45
7.	Changes in Sequences of Care	47
8.	American Hospital Association Sample Organization Chart	53
9.	Modes of Information Utilization	59
10.	Three Sections of the Medical Record	62
11.	Information Combinations	64
12.	Organizational Components of Information Materials Handling	67
13.	BCN Information Relationships and Applications	69

5

P R E F A C E

This report was prepared under the contractual sponsorship of the National Library of Medicine (NIH Contract 43-67-1152). It is a summary of the early project work that was conducted by the Interuniversity Communications Council (EDUCOM) in anticipation of the design and development of a national biomedical communications network.

This report concentrates on the impact of information in health care and not on the longstanding and traditional use of information in medical education and research. The requirements of the physician are the subject of this report. The allied professions and supporting health care personnel which make up the total cooperative enterprise are discussed only in this context.

A network configuration for a national system is not discussed for the reason that criteria for "regionalization" include factors other than desirability. Information in health care, as discussed in this report, is considered to be only one criterion and is presented accordingly.

A B S T R A C T

The report stresses the fact that while there is unity in the continuum of medicine, information in health care is markedly different from information in medical education and research. This difference is described as an anomaly in that it appears to deviate in excess of normal variation from needs common to research and education.

In substance, the report states that information provided to researchers and educators can be anticipated to a large degree and that this lead time can be used to advantage by publishers, authors, and lecturers. In problems of medical care, the lead time is lacking and the information system must react to inquiries after-the-fact. In essence what was good for education and research is not as effective in health care and collateral resources are called in to fill the void.

This report calls for an upgrading of directories, compendia, and guides to enable physicians to locate and use information in a severely time-constrained problem environment. It implies that there should be some innovative re-grouping of all types and sources of information to allow the clinician to gain as much from a national network as do the researcher and educator.

I. INTRODUCTION

Certain needs of medicine and health can be met by the proper handling of information to expedite the transfer of research results and experiences to clinical practice. This is a statement contained in many of the reports of Commissions, Task Forces, and Committees on the health, welfare, and education of the people of the United States.

The Regional Medical Program of the Public Health Service, established in October 1965 by the authority of Public Law 89-239, resulted from the 1964 study of the President's Commission on Heart Disease, Cancer, and Stroke. One of the needs was expressed as follows:

> A creative partnership must be formed among the Nation's medical scientists, practicing physicians, and all other of the Nation's health resources so that new knowledge can be translated more rapidly into better patient care. This partnership should make it possible for every community's practicing physician to share.....resources.

Dr. William Stewart, the Surgeon General, in a talk to the National Health Forum of the National Health Council in March 1967 on the subject of Public Law 89-749, the Comprehensive Health Planning Act, talked about comprehensive health as follows:

> Planning begins with the aspirations of society. The first step is to articulate these aspirations into meaningful goals.....The second step is to break these down into a set of objectives..... Information systems are the next indispensable ingredient of the planning process. Data are needed as to the nature, extent, and location of the problems identified as target objectives. We need to know the resources currently available to combat the problem, the resources that could be diverted from other purposes, the effect of this diversion, and the additional resources that could be developed.

The President's Committee on Mental Retardation, appointed in 1966 as the result of a report from The President's Panel on Mental Retardation, identified ten urgent needs in

their report, "MR 67." The fifth need stated the following:

> A national mental retardation information and resource center should be developed. The center would serve as a central storage and dissemination point for information on mental retardation and mental retardation programs. It would gather, systematize, and furnish information on research, studies, programs, and services.....Consultative services would be made available.....A basic directory will enable any citizen to locate a contact for mental retardation program and information assistance.

Providing data and general information services to members of the Association of American Medical Colleges is recommended in the report, "Planning for Medical Progress Through Education" by Lowell T. Coggeshall.

> Certain basic data and general information services are essential.....By serving as a central agency for collection and distribution of information about trends and needs in education for health and medical sciences, the association can provide an important resource of objective data for the use of all organizations and agencies concerned with health. A broad variety of information should be gathered and disseminated on a clearinghouse basis.

The 1962 Airlie House "Conference on Health Communications" sponsored by the former Surgeon General, Dr. Luther Terry, addressed itself to the information explosion and the new techniques of communications. One of the recommendations read as follows:

> Support research and development directed toward establishing a coordinated network for automated biomedical information processing. The vast amount of biomedical communication which needs to be carried out can probably be facilitated by new electronic means. Eventually, a coordinated network may relieve the increasing pressure on libraries and speed the flow of information to scientists, practitioners, health administrators, and the public.

These and other reports show no evidence that the value of information is denied in any quarter of the medical and comprehensive health community. In almost every case, however, each phrasing of the problem includes some caution that information handling must lead to a clear gain in patient care. This cautionary note implies that library service should be more concerned with, if not directly involved in, the needs of clinical service. Where libraries have traditionally served medical education and research, it is now implied that information resources should be extended directly to the clinician for the ultimate, if not immediate, benefit of the patient.

In fields other than medicine, the standard technique for the communication of a new requirement such as this is by specification of the requirement by the buyer and fulfillment of that specification by the seller. The specification becomes the communication medium; the system is designed and controversy is reconciled by way of specification. Quantities are the governing language and they determine satisfaction.

If the information problem in medicine is to be solved by specification, specific data are needed. A statistically valid count of physicians and allied personnel, their affiliations, locations, information requirements, and rates of use would be required in addition to a clear description of the functional interrelationships of people in medicine and health as they perform tasks in various problem environments.

Patient care is patently not quantifiable, at this stage of medicine, nor is enough known about medicine and its practice to produce a set of rigorous postulates against which an information system could be designed. The deficiency of data, one of the key ingredients of a specification, is mentioned in the 1967 Report of the National Advisory Commission on Health Manpower. The following statement appears in the introduction to that report:

> One overall caution: Our conclusions and recommendations are necessarily qualified because of our inability to obtain truly adequate data on the medical care system from existing sources...
> ...There is a serious lack of the consistent and comprehensive statistical information that is required for rational analysis and planning, despite a surfeit of numbers about health.

According to this statement, a specification cannot be written and the plan for a biomedical communications network is constructed on the bare framework of an expression of need for information, a resolution to investigate the problem, and an admonition to direct the solution to some useful purpose. These requirements, rephrased in engineering language, appear as follows, and are the general statements to which details will be added in this report:

1. The biomedical communications system shall be a mission-oriented information system.

2. It shall be accessible to all members of the medical and health community without financial penalty.

3. It shall be responsive within the time constraints of the user.

4. It shall be addressable in the natural language of the user.

5. Applied as well as research information shall be included in the data file.

6. The system shall accommodate, at least by catalog or index, all media of storage.

7. The system shall include a directory to sources of information as well as a collection of materials and resources.

8. Data collection of significant statistics shall be part of the system responsibility.

9. System effectiveness shall be determined by increase in quantity or effectiveness of patient care.

10. System implementation shall be effected by phases so as to insure application of results gained from experimentation, demonstration, and other such early phases of implementation.

II. AREAS OF INTEREST IN HEALTH CARE

The two most pressing needs in contemporary medicine and comprehensive health are increases in manpower and reductions in health care costs. New information systems in medicine and health, if the admonitions of commissions and task forces are heeded, must include these as design targets or, in any event, not detract from the mainstream of effort devoted to them.

Figure 1 lists the various needs in medicine and comprehensive health. The list is divided into the functions of research, education, and service. Each is further subdivided into the organizational components of administration and organization, manpower, facilities and equipment, and finance.

Medical subjects of continuing interest, such as determining the causes of and devising better treatments for disease, are not included in this list. These subjects lie wholly within the substantive framework of medicine and are outside of the scope of this report.

The list is subdivided into functions and organizational components to illustrate the fact that certain needs are interrelated with others and that they are not necessarily common to all divisions or sub-division. Staff shortages in service, for example, are related to workload increases. One aggravates the other and, similarly, a solution to one will benefit the other. It also illustrates the fact that this need is particularly acute in medical care.

No differentiation is made between medicine and comprehensive health for the reason that the specific functional differences between them, if any, are still being clarified. Where medicine focuses primarily on the prevention and cure of ailments and diseases, comprehensive health includes the social, cultural, economic, and environmental factors that influence them. The broader scope of comprehensive health hints that the universe of medicine is wholly contained within the universe of comprehensive health and that the functions of each can be described according to this relationship. This is a matter yet to be resolved and for that reason is omitted from this report.

ORGANIZATIONAL COMPONENTS	FUNCTIONS		
	RESEARCH	EDUCATION	SERVICE
ADMINISTRATION & ORGANIZATION	Definition of Objectives Program Management Program Evaluation	Methods Development Curriculum Public Education	Standards & Procedures Quality Control Audit Scheduling & Utilization Records Management Information Support Systems
MANPOWER	Interdisciplinary Skill Utilization	Teacher-Student Ratios Preceptor Development	Staff Shortages Workload Health Team Utilization Professional Growth
FACILITIES & EQUIPMENT	Facilities & Equipment Costs	Multi-media utilization Communications Resource Limitations	Laboratories Instrumentation Special Clinical Facilities
FINANCE	Accounting Audit	Revenue Limitations	Costs of Care Revenue Billing

Fig. 1 KEY AREAS OF INTEREST IN MEDICINE & COMPREHENSIVE HEALTH

Both manpower shortages and the rising costs of health care appear in the third column under the service function. Both embrace other problems that appear in the same grouping. This partially accounts for their complexity and for the lack of definitive solutions.

Staff shortages in service can be traced to a number of causes:

1. a greater demand for medical service
2. overall population increases
3. service deficiencies in disadvantaged areas
4. decline of general practice, and
5. increased benefits of research and education.

Items (1) and (2) are causes of increased workload which, in turn, are reflected as staff shortages. Surveys of physicians and their practice environments conducted as early as 16 years ago[1] indicated that the workweek of physicians was exceedingly long and that the patient load was high. Any increase in patient population or demand for service per patient would saturate the physician and generate a need for additional staff.

Item (3) is an isolated cause attributable to the current awareness of inequities in health care and of the ills that result from these inequities. Patients are the rural populations, inner city residents, and the economically and otherwise disadvantaged.

Items (4) and (5) are interrelated in that there has been a decline in physicians content with general certification and many potential practitioners are being drawn off into the increasingly attractive fields of research and education. In recent years, for example, only 2% of interns went directly into general medical practice[2] resulting in a decrease

---

[1] Peterson, Osler L., et al., "An Analytic Study of North Carolina General Practice 1953-1954," Part 2, Journal of Medical Education, December 1956.

[2] Report of the National Advisory Commission on Health Manpower, Vol. I, November 1967, USGPO, page 14.

in the numbers of physicians available to provide general family care. What percent are drawn off into non-clinical roles is not exactly known but the rise in research budgets would indicate that research does affect the availability of physicians for patient care.

Various attempts have been made to meet manpower needs and some of these have produced new problems. The 14 new medical schools which propose to supply over 1,000 new physicians annually in addition to those already graduating from existing medical schools, have temporarily drawn faculty from other schools and created a need for additional preceptors. Presumably part of private practice will be drawn off to teaching assignments also.

Similarly, the development of health care teams, the education of physician "assistants", and the retraining of former (but not currently employed) allied health graduates to fill new roles, which were conceived to increase the patient-per-unit-of-time capacity of the physician have generated new requirements. The new health care teams are lacking a precise description of functional relationships and problems of job definition within this team structure have arisen. Part of this problem was described by the National Advisory Commission on Health Manpower in a statement which read, "(There is) an almost total absence of.....an analysis and grouping of skills required for health care."[3] This need for a functional analysis is a by-product of the original manpower problem.

Rising costs, the other most serious problem in contemporary medicine and health, is exclusive to the service function and does not appear in research and education. There is no evidence in fact that any other problems in research and education are interrelated in any way with this problem.

Two other financial problems are listed in the same group with high costs. These are the deficit budgets of

---

[3] Stewart, William H., "Education for the Health Professions," White House Conference on Health, Washington, D.C., Nov. 3-4, 1965.

institutions providing patient care and the unusual system of multiple billing to one patient per hospital event.

Patient costs reflect the financial health of hospitals. If the institution depends on consumer revenue and the financial health of the institution wavers, the end result will be high, if not excessive, consumer costs.

In this case, the hospitals are institutions with deficit budgets dependent on voluntary income for cash flow balance.[4] The difference between expense and income must be sought from a third party. Regardless of who the third party is, the prime revenue source will be pressed to minimize the deficit.

Multiple billing to each patient is the other chief financial item in the same group with high costs and deficit budgets. This is peculiar to many American hospitals and the physicians that practice in them.

The American medical institution has been called an unusual business organization in that the services of that institution are prescribed by physicians who are often not employees of the institution. The requirements of these non-employees in great part determine the capital investments of the institutions and the work performed by the individuals employed by the institutions. By this arrangement the health institution is partially captive to a non-employee. In essence, the physician is a private businessman and the hospital is a private, albeit non-profit, business. The two are bound together by a professional agreement and not by contract, which is the standard form of business communication.

By this arrangement, accounts to patients are handled by each of the businesses involved in the transaction. Although the account is registered in one person's name, the billing comes from each of the parties involved in the transaction except those directly employed by the hospital. In the case of childbirth, a single patient, for example, will receive bills from the obstetrician, the anesthesiologist, the hospital, and perhaps from a private laboratory.

---

[4] Statistical Abstract of the United States, 87th Annual Edition, 1966, U.S. Department of Commerce, pp. 69-76.

The four accounts cited in this example reveal disparities in profit (or loss) despite the fact that all are involved in a single patient venture. The obstetrician, the anesthesiologist, the hospital, and the laboratory operate at four different net profit (or loss) levels. The obstetrician's net gain before taxes is 35% to 40% less than gross income. The anesthesiologist's net gain is very close to gross income. The hospital's gross income is appreciably less than cost, and the laboratory's net is probably 5% to 7% of gross.

One system with multiple accounts leads one to suspect that account complexities result in additional overhead costs, which eventually find their way back into the costs of patient care.

These problems do not include poor credit risks, medical care for the indigent, community health programs, third party payees, and the like. Each of these, directly or indirectly, affects the finances of institutions and individuals who must pay for health care.

Other areas of interest in research, education and service are not as critical as the two mentioned above. Some general comments on these are as follows:

1. Research

Defining research objectives, managing research programs, and evaluating their results are problems that arise from the very large national investment in medical and health research. The University of California Los Angeles, one of the institutional recipients of the grants award program of the National Institutes of Health, for example, received 315 research grants totaling 15 million dollars from the Public Health Service in fiscal year 1967.[5] The grants ran from a low of $2,700 to a high of $1 million. UCLA's total grants award represented approximately 1/50th of PHS's extramural investment in research for that year.

---

[5] Public Health Service Grants and Awards, FY 1967 Funds, Part I, Research, pp. 26-34.

One aspect of grants management is fiscal and the other is substantive. Fiscal management consists primarily of account processing and control. Substantive management consists of review, assignment, and evaluation. These become more difficult as the number of funding sources, review groups, and volume of grants increase. Titles of grants are inadequate for complete comprehension of subject coverage and research objectives. As a result, reviewers have difficulty determining whether the grants take advantage of current work and whether one research program is redundant with another.

In addition to research volume, the broadening base of research in medicine and comprehensive health is a trend which affects all of the areas of interest in research. Biologists, chemists, physicists, mathematicians, sociologists, economists, and others are becoming increasingly involved in research directly related to medicine. This broadening horizon has a direct effect on a researcher's ability to search retrospectively into the research literature. The large number of publications that appear in any one field, the lag in reporting scientific accomplishments, language differences between subject fields, and the classification and indexing of material are part of this problem.

According to Feinstein's concept of the dependence of clinical medicine on other fields[6] the horizon of medicine might extend beyond related subject areas of interest. Medicine is linked to human health. From there the links extend to human development, human speech, linguistics, semantics, philosophy, mathematics, physics, chemistry, biochemistry, physiology, and back to medicine. Feinstein provides reason to suspect that the research will begin to appear in fields not commonly associated with medicine and health.

There are indications that research in medicine, although peculiar in language and purpose, is not significantly different from research in other fields. This leads to the prospect that there will be some commonality in solutions to problems and that medicine will benefit accordingly.

---

[6] Feinstein, Alvan R.,"Clinical Judgment," The Williams and Wilkins Company, 1967, 414 pages.

2. Education

Methods development, curriculum, multi-media utilization, and most other items of current interest to education are traceable to the involvement of medical and allied health schools in medical and health service. These involvements consist of postgraduate education, continuing education, the quality of health care administered, the availability of services and facilities to practitioners, and the numbers and fitness of their students to meet practice roles.

The passive nature of their traditional involvement is changing to a more active and aggressive stance. It is this aggressive attitude, in many cases, that has led to new areas of interest and problems. This attitude has also generated some controversy between the schools and medical associations on the relationship of the educational institution to the practicing physician.[7]

The development of teaching/learning methods and curriculum revision are exclusive to medical and allied health schools. Methods development is related to computers, teaching devices, various media for handling instructional materials, and communications technology which afford the institution with opportunity for direct contact with a widely dispersed group of practitioners. Methods development is partially traceable to the fact that medical students have always been close to saturation and that new techniques are needed for effective learning.

Curriculum reform seems to be a continuous venture in medical schools. Since the landmark changes of Case Western Reserve University in 1945, there has been constant re-evaluation and revision of medical curricula. These changes range from adding courses in physical science, shifting gross anatomy from first year to second year teaching, and cutting down many required courses to allow for as much as 30% elective time. The objective of curriculum reform and experiments with teaching methods are the improvement of the quality and numbers of physicians involved in patient care.

---

[7] Council on Medical Education, "Planning for Medical Progress Through Education," JAMA, Sept. 12, 1966, Vol. 197, No. 11, pp. 187-190.

Another area of interest is the preceptor method of teaching clinical medicine, where the medical student observes and learns through a mentor. Institutions are asking whether the preceptor technique is an effective way to handle a large number of students. Preceptor recruitment, as well as its technique of teaching, is understandably involved. The subjects of concern in this area are the degree to which the preceptor technique can be improved or by what technique it can be replaced.

Inter-institutional communication or networks are the problem domains of institutions such as EDUCOM. Medical school educators who have been faced with problems of resource utilization voice the opinion that the new technology and communications techniques could be used to encourage sharing between institutions. The goal of these sharing ventures would be to increase effectiveness or capacity without an equivalent investment. The concern in communications is the identification and utilization of that material deemed to be of potential value to the medical community.

Multi-media materials go hand-in-hand with networks as well as teaching/learning techniques. Films, videotapes, and audiotapes fall into this category. Which of these materials are valuable to the health community and how they are to be located and communicated to other users is the problem.

Communications is an area of interest which arises out of networks and multi-media handling. Related problems are the lack of knowledge of user requirements and the high costs of wideband communications systems.

3. Service

Topics of current interest in medical and health service are virtually unlimited. They reflect the concern of clinicians, educators, and researchers in problems of medical care.

The National Forum on Quality of Health Care, conducted in Los Angeles in early 1968, emphasized the need for high quality in medical service. One of the needs was a clearer definition of quality in the form of standards and procedures. However, even amongst institutions similar in purpose and size, uniform practices and standards are difficult to devise and enforce.

Audit, related to uniform practices and standards, includes both qualitative and quantitative review of patient care activities. At the present time, the auditing function is served largely by various committees. Committee involvement is, for the most part, voluntary and enforcement of committee operations is difficult.

The audit function and most medical care operations relate to the medical record. Maintaining records is complicated by the fact that the medical record is an accounting tool, teaching tool, a retrospective research reference, a legal record, and a diary of patient care progress. The computer, with its large data-processing capabilities, figures strongly in various attempts to handle the medical record.

Interest in equipment is traceable to the rapid growth of technology and instrumentation advances being made in medicine. However, the costs and obsolescence rates of these equipments are high. These generate problems of building facilities to house this equipment, training technologists for operation and maintenance, and assuring the physician of the equipments' direct value to patient care.

Technological interest also extends beyond instrumentation and specific devices for patient care. Clinical research facilities may evolve around new technology or they may be concerned with new concepts and techniques partially or not at all dependent on new equipments. The concern that arises is the determination of actual benefits that accrue from these efforts. Some benefits are observable and measurable. Many are not. Attempts to develop measures of quality and evaluation indicators are directed to this problem.

Libraries, discussed in depth in a separate report by Kenney,[8] are concerned about ways to serve the community of practicing physicians. One key problem is the inability of many hospitals to fulfill the role of a service library, thereby forcing the resource library to assume this function.

---

[8]Kenney, Brigitte, "Health Science Libraries Today," Research Memorandum No. 2, December 1967, 179pp.

Perhaps, a more significant problem revealed by this study is the variety of information required by a practitioner for patient care compared to the traditional materials processed and handled by medical libraries.

III. APPLICATIONS OF INFORMATION

This section will briefly summarize each of the key areas of interest in medicine and add a statement on the application of information to each. The applications reveal that not all functions share the need for information of the type traditionally maintained in general collections. In many cases the need is for original information or surrogates to original materials. In others the primary need is for special collections of audio-visual materials or various ephemera.

This section emphasizes the urgency of applied information requirements at some sacrifice to a discussion of the needs of researchers, educators and clinicians for academic knowledge. In this regard it should be sufficient to state that medicine is a continuum and that it is critical for all to maintain a high degree of medical awareness. The consequences of the lack of knowledge have been illustrated so frequently that any single example would tend to dilute what is already commonly recognized.

Academic support of this type is basic to the mission of medical libraries and continuing efforts should be made to play this role effectively. The problem facing the contemporary library is how the library should expand its function in order better to serve the needs of the community.

These summaries of information applications are reflections of conversations and conferences with faculties of medical schools, federal administrators of grants programs, clinic staffs, private practitioners, society directors, allied professionals, and others. Ideas and opinions were reinforced, in many cases, by research and demonstration programs.

One example of a demonstrated application of information to medical care is the Drug Information Analysis Service (DIAS) of the University of California San Francisco. The DIAS is a service housed in a small, back room of the medical library. It is a joint venture between the Medical Center Library, the School of Pharmacy, the Department of Pharmaceutical Services, and the Division of Clinical Pharmacology in that the room, library reference materials, and a key to the library are supplied to the fourth-year pharmacy

students and faculty who man the DIAS under the direction of the various participating departments and divisions. The DIAS is the information resource of the University's Moffitt Hospital and other local hospitals. In addition to references and handbooks, an evaluated guide to these references, selected clinical medication records, ephemera, applicable journal citations and clinical abstracts are maintained in the DIAS. Telephones and electro-writers connect the DIAS to ward pharmacists and physicians.

The object of the DIAS is to bring the pharmacist closer to the patient's bedside and, conversely, to provide the clinician with a viable resource of pharmacy experience backed up by various types of information. The DIAS demonstrated that a narrow specialist using all information materials (original, surrogates, processed, and ephemera) sometimes provide a service not otherwise available.

The DIAS is not computerized. It has been supported only by departmental funds. It has not been reported in the medical literature. There is little, if any, advanced scientific or engineering appeal to the program. On the other hand, it is an unusual partnership of various schools and departments. It has been operating for over two years and has since spread to the non-university hospital. It is voluntarily staffed and it brings physicians and allies closer together in a common venture.

This discussion of information most useful to people involved in medical care is influenced by this "model". All types of information are included in the following:

1. Information Applications to Research

a. Goals and Objectives

Information is required by the researcher during the development of research postulates and research approaches to develop an awareness of past accomplishments in related fields and on-going work in the same field. Information should include the availability and capability of special research facilities and equipments, general bibliographies, and researchers involved in related programs.

b. Grants Management

Management of grants is an institutional, rather than an individual, problem. Periodic updating and reporting of grants are usually sufficient, provided that the summaries are indexed in sufficient depth to allow easy access to on-going programs by new researchers. Information on federal grants is available. Federal grant information in greater depth is desirable. Supplementary information should include activities being conducted under private grants and grants from state services.

c. Interdisciplinary Skill Utilization

Starr, in testimony before a Senate sub-committee[1], listed nine medical problem areas which could receive major benefit from the participation of skilled development engineers and applied scientists. He recommended that certain programs be undertaken by universities as a combined task of their engineering and medical schools. Whether or not these programs become joint ventures as suggested, information on interdisciplinary efforts in scientific and engineering fields on behalf of medicine should be compiled to stimulate interest in such ventures. Information would be of interest to physician, engineer, and scientist.

d. Special Facilities

Facilities and special equipment are expensive. Obsolescence rates of equipment are high. A directory of special facilities and equipments available for use by others would extend research or service capabilities. The fee-for-service section of the Office of

---

[1] Testimony of Dr. Chauncey Starr, Dean, College of Engineering, UCLA, before the United States Subcommittee on Government Research, March 2, 1967.

Learning Resources of the University of Colorado Medical Center is an example of a plan to amortize facilities and equipment over a large base. Information materials should include directories of available facilities and services and product catalogs of commercial suppliers.

e. Accounting

Contracts and grants accounts require special handling. Contract management is bound by procurement regulation and governing provisions of the contract or grant. Accounting for expenditures of public monies, especially on contracts, is a potential high overhead burden. Small institutions often do not have the administrative staff to handle these incomes. Information materials should include listings of the applicable documents of the Government Printing Office and directories of small business offices and other assisting agencies.

f. Audit and Evaluation

Evaluation of the benefit of research can be extremely complex. Statistical gains (i.e., economics, number of patients handled) are often inadequate. Quality evaluation indicators are lacking. Evaluation reports may not qualify for formal publication. Information should include methods of evaluation, ongoing evaluation programs, and evaluation and audit reports.

2. Information Applications to Education

a. Public Education

The education of the economically or educationally disadvantaged is a complex problem of content, methodology, and motivation. These problems are being attacked by health service research and community medicine groups. Once these techniques have been developed, the

implementation of public education will be shared by local institutions. Information, such as patient counseling films and health care guides, are being developed. Information should include catalogs of materials that are available.

b. Methods

Teaching methods per se enjoy little priority in medical schools, hospitals, and agencies supporting health care programs. The steady growth of teaching materials and increased use of TV and visual media are introducing new opportunities to educators. Audio-visual coordinators and directors of learning resources centers are primarily concerned with the materials and equipments of that institution. An unfilled need is for a complete and descriptive catalog of audio-visual materials that are available from other sources.

c. Curriculum

The earliest curriculum studies were done by Case Western Reserve University and Duke University. Harvard, Pennsylvania, Vermont, Yale, Stanford, Albert Einstein and others are in the process of curriculum modification. Changes include more free time, early patient contact, intra-school communication, and concentration on core courses. Curriculum information and use or experimentation with new educational tools is a classification sub-heading that will lead educators to current programs in these areas.

d. Preceptor Recruitment

Medical schools receive incentive awards for increasing the number of pre-doctoral students over previous years' enrollments. Total enrollment, however, is partially limited by the clinical training capacity of the university hospital and its affiliates. Attempts have been made to increase this capacity by increasing the number of preceptors. A

network of communications, using proposed videotaped case histories to supplement local exposure, will open the path to the increased utilization of preceptors in remote communities.

e. Multi-media Production

Various audio and audio-visual materials and communications media are being used in medical schools for interview records, deficiency training, self-assessment, remote lectures, personnel training, and lecture augmentation. Editorial practices are not uniform. Techniques for indexing visual materials are incomplete. Multi-media production and teaching methods are interrelated. The directory requirements for each are similar.

f. Interuniversity Communication

It has always been difficult for any one medical school to be equally proficient in all fields of medicine and comprehensive health. It is becoming increasingly difficult for any one medical school to support even selected areas of specialty. Resource-sharing has been discussed, but solutions are lacking. A directory of resource programs available for sharing will alleviate one small part of the problem. Information should include directories of services, facilities and equipments available for use by others.

3. Information Applications to Service

a. Standards and Procedures

Standards of quality and uniform procedures for care are a continuing concern. Some laboratories publish tables of normal values. Random behavior of normal values is being studied. Information should include these and other surrogates to original materials.

b. Audit

Audit is a function delegated to review committees in hospitals and, on a national scale, to the Food and Drug Administration. A form of audit is assumed by medical specialty boards when certification in that specialty is requested by a physician. Audit reports are communications that are usually private to the individual and the organization concerned with the audit. Information of national interest includes the innovations and concepts of audit in medicine and comprehensive health that are being attempted as well as evaluations on the effectiveness of these efforts.

c. Records

Evaluation of any patient care system eventually leads back to the medical record. As long as patient care is one objective of a medical information system, some aspect of the medical record must be included in the system concept. A closer match between disease indexes and medical subject headings is envisaged. A closer relationship between the medical reference librarian and the medical record librarian is probably desirable but perhaps not practical. Statistics drawn from medical records are appearing in the form of cancer registries, collaborative reports, and other bio-statistical summaries. These are surrogates to original materials. Information systems should include these surrogates.

d. Legal

Legal problems in medical service range from the privacy requirements of patients, the legal records of institutions (surgical authorzations, release against medical advice), to appellate decisions on health law. The Health Law Center of the University of Pittsburgh is a special collection devoted to the latter. A deep index of information in the Health Law Center will provide access by others to that information.

e. Staff Shortages

Proposed solutions to the staff shortage problem appear in many forms. The variety of solutions include the education of physician "assistants", the training of nurse specialists, the development of health care teams, the training of family physicians, and the establishment of community health centers. Compendia of on-going programs will help develop an awareness of new techniques and organizations trying to alleviate this problem. Information materials should not be limited to processed materials which appear long after the programs have been evaluated.

f. Retraining

Nurses, technologists, and other health care personnel, who may not have been working, are retrained and re-employed to alleviate the manpower problem. This problem is related to the staff shortage problem. The information requirements of the two are similar.

g. Continuing Education

Continuing education is a problem of interest to medical schools, specialty boards, medical associations, medical clinics, nursing associations, and community hospitals. The traditional short-term course is the most frequently used method for this type of education. Medical and comprehensive health personnel located closest to institutions offering these courses have been in the most favorable position to take advantage of opportunities in continuing education. New programs propose to extend the arm of continuing education to remote areas, to patient-saturated private practices, and to others disadvantaged by virtue of lack of time or opportunity. Information materials listing courses and seminars are published. Information should be included on innovative programs of universal interest, particularly on the effectiveness of these efforts.

h. Support Specialties

Collections of special information materials are currently or potentially available from the Health Law Center, National Medical Audio-visual Center, the Special Information Centers of the National Institute of Neurological Diseases and Blindness, the Clearinghouse on Self-Instructional Materials, the Mental Retardation Research Centers, the Myocardial Infarct Research Units, the Health Service Research Centers, the National Center for Urban and Rural Health, the American Hospital Association Centers for Continuing Education, the Center for Research in Scientific Communication, the World Health Organization Biomedical Research Information Service, the National Clearinghouse for Mental Health Information, the proposed National Mental Retardation Information and Referral Center, the National Clearinghouse for Poison Control Centers, and others. Each of these is a resource center for special information materials. In many cases there are special skills affiliated with the centers. Information on personnel services as well as materials should be included in directories.

i. Laboratories

Laboratories (chemistry, hematology, serology, bacteriology, microbiology, and urology) have a bearing on many of the current problems in medical service. Laboratories provide input to hospital committees charged with audit and review functions. Laboratories are major sources of revenue. Laboratories are agents of quality control in that they are used to identify environment induced infections. Laboratories are major factors in the length of hospital stay. The larger of these laboratories can perform tests which exceed the capability of smaller hospital laboratories. Information should include directories of special capabilities that are available to the medical community.

j. Libraries

The problems of health science libraries are in an appendix to this report. These libraries, like other general and special libraries with limited staff and budgets, are faced with the additional problem that the principal resource libraries are often required to be service point libraries as well. Expanding the scope of service and the width and depth of collections in this environment is desirable but impractical. In this case, staff and funds are the main problem. The medical library community seems to be well informed. Deeper information on the location and contents of special collections will be helpful.

IV. TYPES OF INFORMATION

All types of information play some role in research, education, and service. This leads to the proposition that collections should be extended to other than traditional media and perhaps, to sources closer to the information originator.

At this point it is acknowledged that it is neither desirable nor practical for most libraries to handle all types of information. Textbooks, for example, used for daily instructional contact, are more properly the responsibility of every student rather than of a central depository. Irregularly produced trade materials are also not central materials for the reason that the processing and handling efforts of library personnel can properly be diverted to more useful items.

This proposition of extending collections is also at variance with journal handling for the same reason that it is neither practical nor desirable to collect every title in a subject field, to index every title in a library's collection, or to index every article in every journal selected for indexing.[1] Thus, for various practical and professional reasons a collection is usually limited to selected published materials and even special collections are cautiously developed.

The National Library of Medicine, for example, lists 18,000 active title entries in their serial record. 8,000 to 9,000 are journals or periodicals as distinct from annuals or hard cover monographs in series. Of these, approximately 2,300 titles are indexed in Index Medicus and about 5,500 into MEDLARS. By this count 30% to 70% of active titles are processed.

The principal holdings of libraries are sometimes supplemented by special or unique collections to meet unusual local requirements. Special collections may consist of deep subject collections or they may include bibliographies, dictionaries, or other materials containing broad subject coverage.

---

[1] Karel, Leonard, Ph.D., "Selection of Journals for Index Medicus", Bulletin of the Medical Library Association, Vol. 55, No.3, July 1967. p. 259-278

The scope of special collections can be expanded to include machine bibliographies, citation indexes, and the various surrogates that are made possible by the use of computer systems. It can be further broadened if films, film strips, film loops, audiotape, videotape, and other media are added.

Regardless of practility all types of information are reviewed and the requirements of an information system are based on the priorities evolving from this review.

A preliminary classification of all information of potential use to all medical and comprehensive health functions shows that there are at least four general types of information. Figure 2 shows these as four intersecting circles. The areas of intersection represent those materials common to each of the main circles and also the amorphous division between materials. The arrows represent general flow and are intended to show that there is a general dependence of processed information on original information and that there is a repetitive pattern, rather than a completely random relationship, between the four types of information.

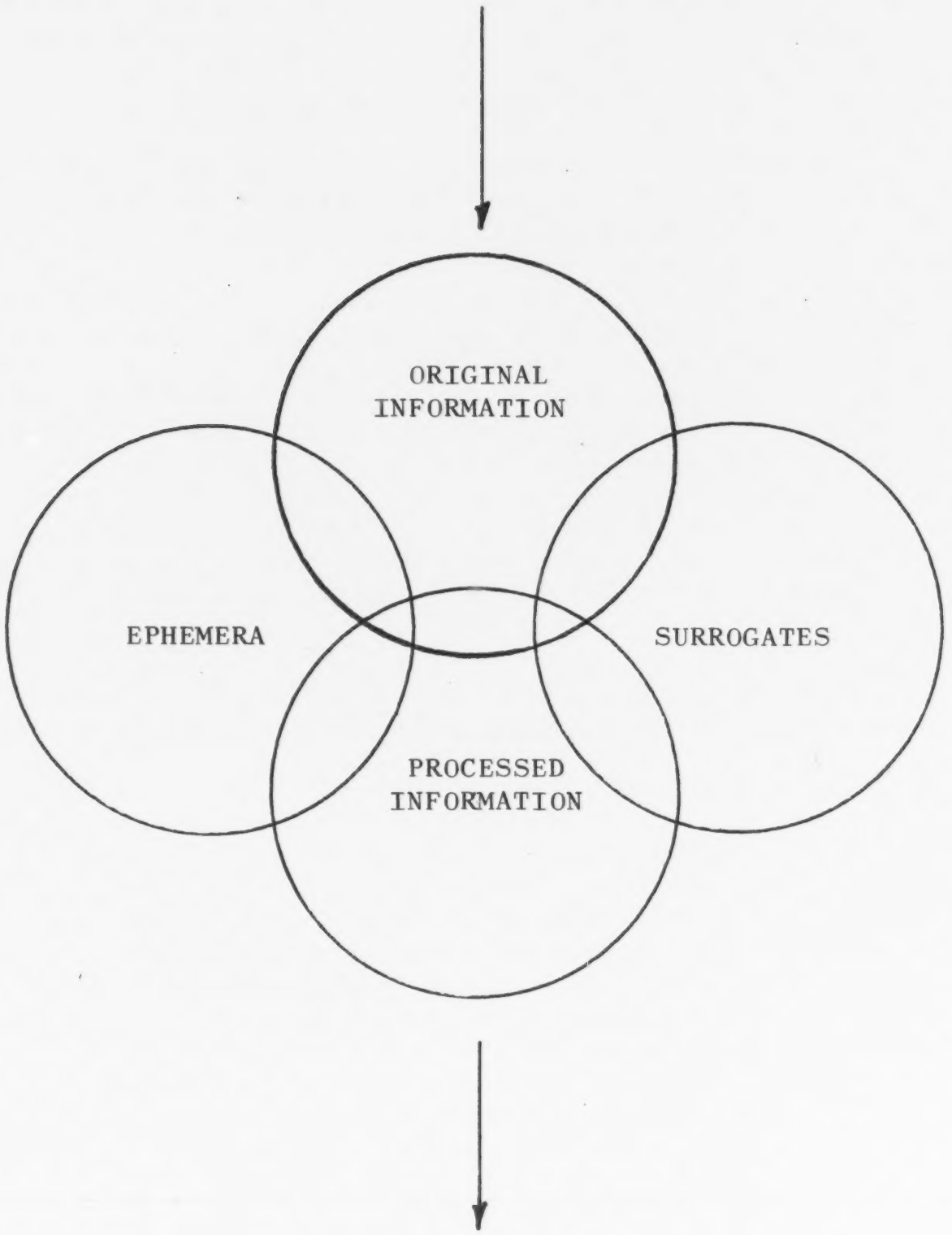
The following is a list of the types of information that are being produced in medicine and comprehensive health:

1. Original information

    a. Patient records

        Identification, personal history, family history, examination, laboratory, radiology, ECG, EEG, notes, diagnoses, medication, special tests, reactions, discharge notes, autopsies.

    b. Committee records
    c. Correlation conference notes
    d. Institutional statistics
    e. Census and surveys
    f. Results of experiments
    g. Research notes
    h. Standards, procedures, and forms
    i. Cultures and slides
    j. Photographs, films, and recordings
    k. Manuscripts
    l. Organization charts
    m. Payrolls



35

Fig.2 FOUR TYPES OF INFORMATION

2. Processed information

   a. Textbooks
   b. Reference books
   c. Handbooks
   d. Periodicals and journals
   e. Various monographs in series
   f. Technical reports
   g. Theses
   h. Directories
   i. Non-printed materials

      Motion picture films, film loops, film strips, cut film, audiotape, videotape, kinescope

   j. Micro-forms
   k. Poison control lists
   l. Toxicology information
   m. Drug efficacy information
   n. Computer programs

3. Surrogates

   a. To original information

      (1) Tables of normal values
      (2) Disease and operation indexes
      (3) Cancer registries
      (4) Stroke registries
      (5) Discharge summaries
      (6) Disease course predictions
      (7) Epidemiologic summaries
      (8) Morbidity and mortality summaries

   b. To processed information

      (1) Book and periodical catalogs
      (2) Bibliographies
      (3) Union lists
      (4) Abstracts
      (5) Reviews
      (6) Clinical experience summaries

4. Ephemera

   a. Trade journals
   b. Product catalogs
   c. Institutional bulletins and reports
   d. Capabilities and facilities directories
   e. Pamphlets
   f. Magazines
   g. Drug inserts
   h. Announcements
   i. Examination and licensing requirements

Original information is that information which precedes, governs, results from, or are observations of patient care transactions, research projects, experiments, demonstrations, or institutional transactions. This type of information is characterized by high volume, irregular format, and a high degree of institutional and personal individuality. Original information in research and education is useful primarily to the local institution or individual. Original information in medical service, particularly the patient record, forms a transaction base which directly governs, controls, or influences succeeding service transactions. Patient records lie at the intersection of the overlapping circles of original and processed information.

Processed information, starting with traditional books and periodicals, includes many non-printed materials and computer printed tabultations which serve a useful communication function in medicine and comprehensive health. Some of these do not lend themselves readily to letterpress operations. Retinal, dermatological, cellular, and surgical visualizations are sometimes more effectively portrayed by motion picture film or color slide.

Surrogates to original information are a second anomaly in medicine and comprehensive health. These emphasize the fact that data from the patient record are quasi-processed materials and not, in fact, original information of limited local value. Tables of normal values, for example, are statistical compilations of the average ranges of "normal" chemical, hematological, and physiological levels in "healthy" persons obtained from the records of a large group of patients. Reported values include bilirubin levels, cholesterol levels, potassium content, sugar quantity, white blood cell count, and so forth. Normal values are sufficiently useful to warrant computing and printing in local institutions. They are not sufficiently valid, however, to justify national distribution.

It is not so much the lack of validity that limits the distribution and use of tables of normal values but rather incomplete knowledge on what is to be considered normal versus what is not normal. The data included in normal values have the appearance of measurable phenomena with certain distinctive random behavior. Randomness, however, in the human body is capricious and probability of good vs. bad is extremely difficult to determine. Tables of normal values, are, therefore, not quite what is usually considered processed information, but, by the same token not completely as unreliable as original information.

Ephemera in medicine and comprehensive health are the trade materials, catalogs, magazines, and pamphlets which are not normally processed into general collections. They deserve attention from the viewpoint of the service function in medicine.

Drug information is critical for medication therapy. Drug information provided to the physician cannot easily be limited to that available from the scientific literature, toxicology compilations, or drug efficacy studies. The scientific literature, for example, stresses research, animal experimentation, and unusual human clinical experiences. Toxicology compilations are primarily adverse reaction data. Drug efficacy stresses scientific evidence of usefulness. Normal or casual prognoses are lacking and for this the trade literature, despite the dangers of unfounded claims, fills a vacuum. The catalog sheets of manufacturers which provided drug information, now appear in package inserts.

The four types of information in medicine and comprehensive health do not reveal what information should be processed through libraries. They do reveal that there are information requirements in medicine and comprehensive health that are anomalous to requirements of other information systems and that, perhaps, some consideration should be given to these anomalies.

V. INFORMATION HANDLING

Figure 3 shows three examples of information handling. The differences in the production and release of one type of information over another reveal the reason why general library collections are dominantly made up of processed information from recognized publishers. They also point out why any discussion of broadening the spectrum of types of information should be accompanied by a careful consideration of the problems involved in such a task.

Example 1 describes the flow of scientific journals; Example 2, product or trade catalogs; and Example 3, surrogates to original information, in this case, stroke registries. The three examples will serve to illustrate the fact that the various methods of handling are factors in the selection of materials for collections and the workload of processing and handling systems.

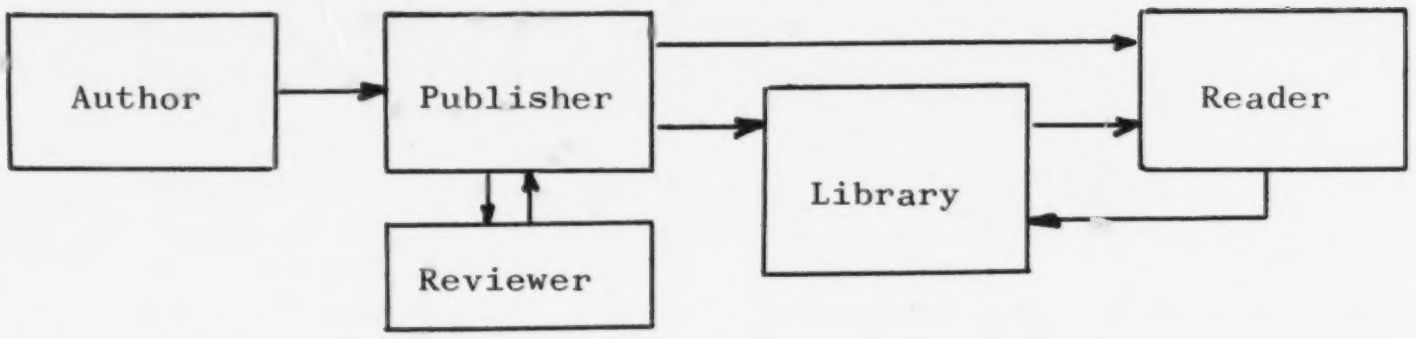
There are significant differences between the three examples. In Example 1, scientific journal handling, the author and publisher are separate. There is a reviewer retained by but independent of the publisher, and there may be separate collection and distribution organizations, usually libraries, which handle loans and retrospective searches into prior publications. In Example 1, the reader benefits from editorial and acquisition screening and organized cataloging which provides access to information. He pays a penalty by having to adjust to a formal classification language and to the delays introduced by the intermediary service organization.

In Example 2, authors, editors, and publishers are members of one corporate body and the handling time between author and reader is shortened considerably because of the absence of editorial screens. Universal cataloging, except in special collections, is usually non-existent. Information flow is dominantly in one direction toward the reader. The reader benefits from the promptness of the system but must rely on his own experience for value judgments of the information.

Example 3 describes the flow of information surrogates. Stroke registries are listed as one example of this type of information. These registries generally deal with specific disease entities and population groups. They

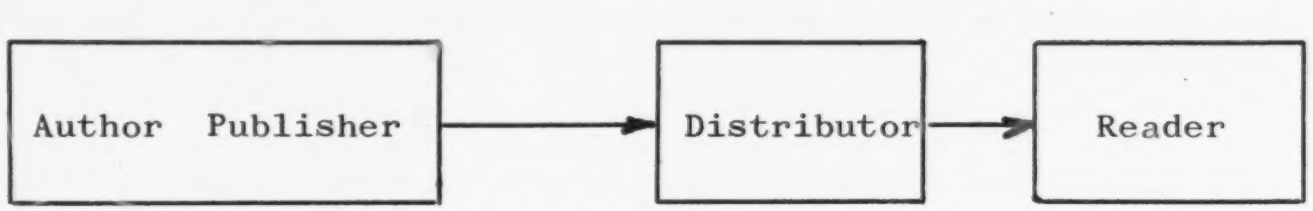
EXAMPLE 1

PROCESSED MATERIAL - JOURNALS



EXAMPLE 2

EPHEMERA - PRODUCT CATALOGS



EXAMPLE 3

SURROGATES TO ORIGINAL INFORMATION - STROKE REGISTRIES

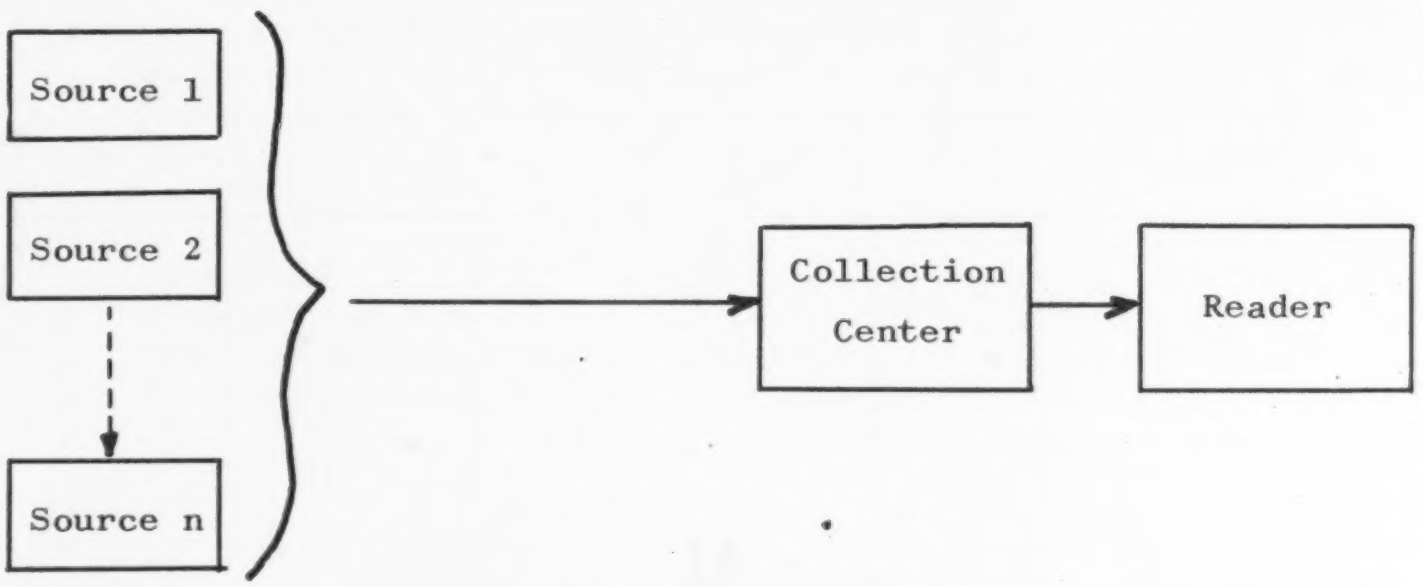


Fig. 3 EXAMPLES OF INFORMATION HANDLING

resemble processed information and can become part of a library collection. In this example, data originate from various sources and are collected, correlated, and organized by a collection center. Compilations of the data are delivered directly to the library and the reader. Data format is prescribed prior to collection to assure coherence and statistical validity.

Registries are probably the oldest of the many record-keeping systems to describe or scrutinize health. They were formerly devoted to estimating and tracking epidemics but have since been expanded to diseases. In the medical and health community, registries are a fundamental tool in recording information upon which medical and health judgments can be made.[1] Stroke registries are cited as an example in this case because stroke is the nation's third leading cause of death; approximately fifty percent of those people experiencing a major stroke die within a month; those who do live often suffer profound disabilities; and certain types of information on stroke can only be provided through registries.

Further details of handling processed information are illustrated in Figure 4. This is a diagram of the interaction between the publisher, the library, and the reader. The principal functions performed prior to publication are listed in the left hand column. On the right is the reader. Two examples of reader interaction with the library are shown.

In this example, readers depend on the publisher and library for processing and handling information for their use. This process does not usually include technical reports, theses, trade materials, or unusual information media. Other information handling processes are used for these materials. The Defense Documentation Center, for example, specializes in the processing and handling of reports resulting from

---

[1] Stroke Registries, "Feasibility and Value for Regional Medical Programs", Report of Subcommittee Task Force on Stroke Registries to the Joint Council Subcommittee on Cerebrovascular Disease and the Division of Regional Medical Programs, September 15, 1967, 34 pages.

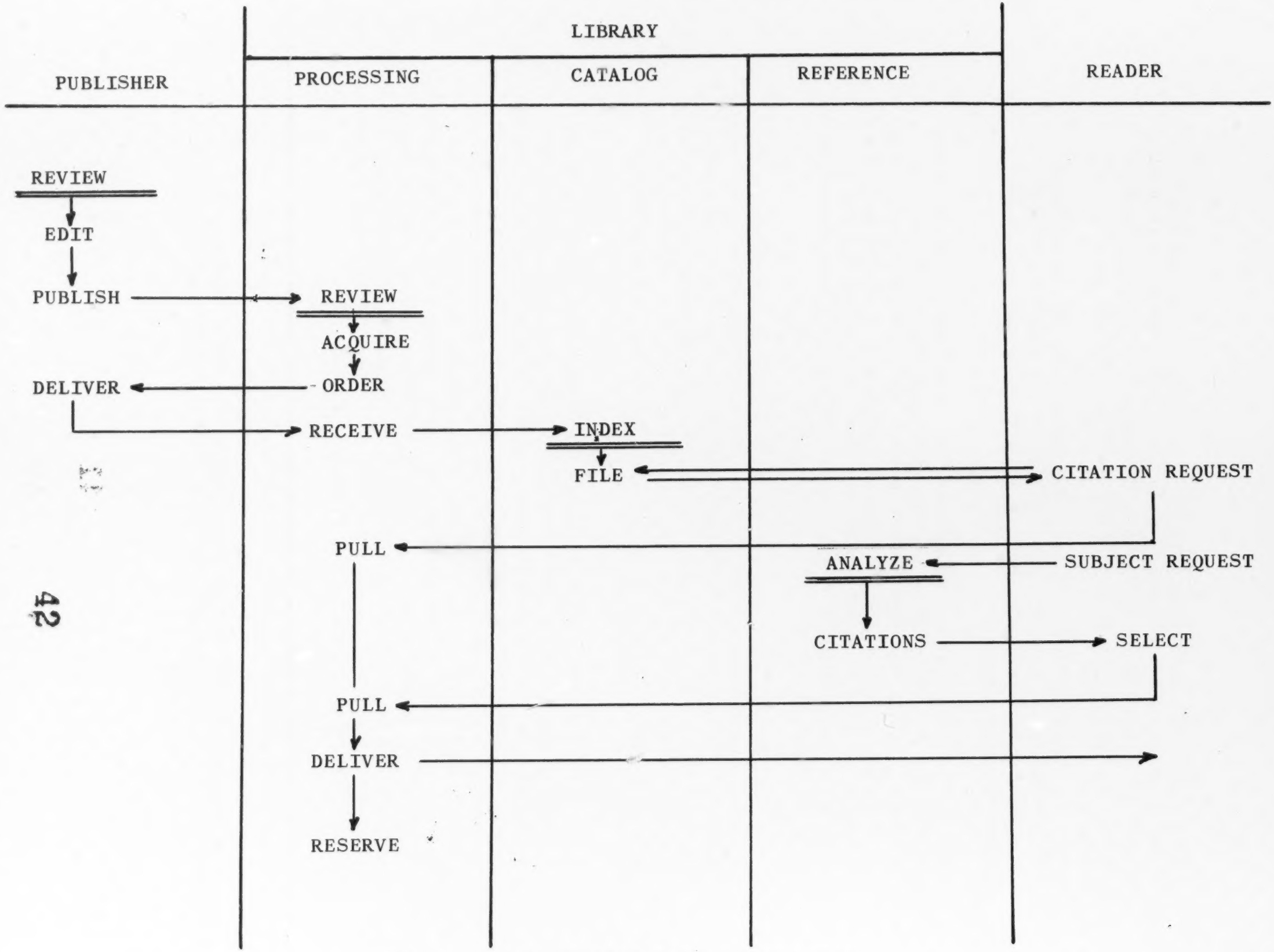


Fig. 4 FLOW OF PROCESSED INFORMATION

Department of Defense contracts. The National Aeronautics and Space Administration similarly handles NASA contract reports. There is no information system for Public Health Service contract reports similar to either of these.

Audio and audio-visual materials are processed like ephemera. Author and publisher are members of one corporate body and the materials are, for the most part, distributed directly by them.

The history and growth of audio and audio-visual materials in medicine and comprehensive health partially explain the reason why formal processes have not been established for the handling of these materials. These materials are new as compared to books and serials. They do not follow a standardized format and their value as a learning resource is not completely understood.

There are also practical problems involved in the handling of these materials. Reviewing and indexing are complicated because many of these materials are not routinely available for review prior to purchase, costly equipment is required for both review and indexing, and the technique of indexing is different from that of indexing printed information.

Indexers must have the processed material in hand in order to classify and index contents and they must have equipment to view the material. Audio and audio-visual equipments are expensive, ranging from less than $100 for a slide projector to thousands of dollars for a videotape monitor and playback unit. An indexer's equipment inventory would have to include slide projectors, film strip projectors with various sprocket holes, various film width, sound motion picture projectors, 8 mm and Super 8 mm cassette projectors, videotape playback units for various tape widths, and various speed and tape width audio playback units.

The handling problem is further complicated by the fact that the techniques of indexing printed material differ vastly from indexing visual or audible materials. Clues to key words may not appear in the audio-visual media. In effect, the indexer may have to describe the visualization prior to indexing.

Cataloging and indexing have been mostly limited to motion picture films [2,3]. Recently, an 8 mm film directory was released by the Educational Film Library Association.[4] Some attempts are now being made to index other audio-visual materials. The University of Mississippi is indexing psychiatric interviews on videotape.[5] The American Nursing Association and the National League of Nursing are indexing visual materials developed for nurses. The Regional Medical Program is compiling a list of audio-visual materials related to heart disease, cancer, and stroke, but from title cards only and The Southern Regional Education Board is investigating the possibility of establishing a joint venture in indexing videotaped patient interviews.

These attempts at indexing audio and audio-visual materials might be the key to including these materials in special library collections. However, since they are processed like ephemera, it is likely that some editorial screening will have to precede acquisition to avoid the posting of deficient materials into a collection.

Audio-visual materials are used to illustrate what happens when there is an apparent need and desire to collect and distribute information but the information has been processed in such a manner that acquisition by traditional libraries is difficult, if not impossible. It does point out the fact that even if all barriers of indexing and cataloging can be overcome, there is still a need for the separate screen to assure quality processing.

---

2 "Medical and Surgical Motion Pictures," a catalog of selected films, American Medical Association, Chicago, Illinois, 1966, 484 pages.

3 "Film Reference Guide for Medicine and Allied Sciences," Federal Advisory Council on Medical Training Aids FACMTA, U.S. Department of Health, Education, and Welfare, National Communicable Disease Center, Atlanta, Georgia, 1967, 379 pages.

4 Kone, Grace Ann, "8 MM FILM DIRECTORY," 1969-70, Educational Film Library Association, Inc., New York, N.Y., 532 pages.

5 Moore, Floy J., Pilot Project, "Use of TV and Videotape in MH Training," Public Health Service Grant Award, No. MH 11397-01, dated May 1, 1968.

VI. INDIVIDUALS AND ORGANIZATIONS

Magraw, in a discussion of high quality health care, states that medical care and health services, in his own experience, are basically a human confrontation.[1] At the end of World War II, however, it was no longer possible to think about medical care in terms of a single, pre-eminent, and uniform professional role because the hospital began to exert a gravitational pull of its own in the medical universe. In this context he describes the two interwoven elements of present-day medical care as (1) human components, and (2) organization. The first is a division of labor - the reduction of complex professional functions into less demanding components. The second is the synthesis of the resulting components into a functioning whole - the organization.

In education and research the organization is a less powerful force than in medical service. The educator is a preceptor; he is governed by the organization, but is very much independent of it. In research the individual enterprise is challenged only by the length of the researcher's excursions into fields other than medicine. In medical service other forces sometimes shift the focus of medical care to the cooperative enterprise. Coincidentally, the greatest number of problems in contemporary medicine are in this very area.

These two - the cooperative health care enterprise and the contemporary problems of health care - intersect at a crossroad. When the cooperative enterprise attacks problems of health care, the combinations of human and organizational variables increase sharply. It is from this viewpoint that Magraw's suggestion that complex professional functions be reduced to less demanding components and that these components be synthesized into a functioning whole is particularly meaningful.

---

[1] Magraw, Richard M., "Components and Organization of Interdisciplinary Teamwork in the Provision of High Quality Health Care", Report of the 1968 National Health Forum, National Health Council, March 1968.

This section will deal with the individuals and organizations of medicine and comprehensive health and will discuss the physician, as both an individual and a member of a cooperative enterprise. There will be occasional excursions into the history of a physician's education and the environment of research and education, but only for the purpose of explaining anomalies in medical service. There will be some emphasis on the problems of staff shortages and the high costs of care because of their criticality. The primary emphasis, however, will be on the individual and the organization, and the implied ways in which information can be used to improve health care.

Physician

The physician is, in succession, student, observer, trainee, and clinician. Two years are devoted to pedagogic studies; two years to case histories and correlations; and one post-doctoral year to training before a physician is eligible for certification. Internship, the last year, can be followed by two to five years of residency leading to specialization.

The first four years of education and the fifth, leading to general certification, are years that increase with time, the student's degree of exposure to patients. As the student becomes increasingly involved in patient confrontation, first as a dependent and later as a semi-independent trainee, he shifts from the deductive description in medical books to the inductive thought of diagnostic inference.[2] Whereas he was called upon to extend the particulars of basic learning into the general problems of humans during his early years, in his clinical years he is required to correlate generalities into one or a few particulars.

Diagnosis is problem-solving and problem-solving is one of the outstanding requirements imposed upon the physician. This is a complex task of which not all humans are generally deemed capable. It is so basic to medicine that there can be no pre-doctoral career branching if the student fails to meet this requirement.

---

2 Takahaski, Kosei, "Logic of Diagnosis and its Processing by Computer - with Respect to Congenital Heart Disease and Brain Tumors", Proceedings on Automated - Data Processing in Hospitals, Elsinore, Denmark, April – May, 1966, pp. 477 - 498.

Data inputs into medical problem-solving are episodic, irregular, or obscure, and associations of these data with past experience or education are only as good as that patient's adherence to norms. A final factor which emphasizes the complexity of this process is that success, governed by the subjective responses of patients, is elusive, and that successes do not necessarily accumulate in convenient, retrievable repositories of experience for retrospective use.

The 2-2-1 division of the plan of instruction into two years of sciences basic to medicine, two years of clinical instruction, and one year of training, is the subject of constant revision, which involves advancing clinical exposure to earlier years in order to illustrate the application of the basic sciences to the diseases of man and providing the student with elective time to foster interest and participation in research. The plan of instruction is gradually becoming a continuum, and there are signs that the sharp, step-by-step exposure to clinical medicine is being abandoned.

One durable fact about pre-doctoral instruction is the focus of education on clinical medicine. For five years, career development, differing only in curriculum details and institutional methods, is identical for all pre-doctoral students. In effect, all students are trained to be clinicians. Research, education, and non-clinical forms of medicine are later branches lateral to clinical activity.

Branching into specialization in medicine is a post-doctoral event. The common purpose imposed on all students during the first five years assumes new proportions as students pursue specialized career choices, some in fields other than clinical medicine.

The period following internship is the period leading to a medical specialty. The specialist can also add a sub-specialization to any of the specialties recognized by the Board or the AMA. For example, once the student completes his internship period and is licensed, the student becomes an accredited general practitioner. After two years of residency and upon passing his board examinations, he is a board-certified pediatrician. The pediatrician may elect to specialize in psychiatry, thereby making him a psychiatric specialist for children.

Residencies, specialty boards, and recognized specialties are not identical. The 1967 Hospital Atlas lists 23 residency training services in the United States. The following are the listed residencies:

1. Allergy
2. Anesthesiology
3. Cardiology
4. Dermatology
5. Gastroenterology
6. General Practice
7. Internal Medicine
8. Neuro Surgery
9. Obstetrics and Gynecology
10. Ophthalmology
11. Oral Surgery
12. Orthopedic Surgery
13. Otolaryngology
14. Pathology
15. Pediatrics
16. Physical Medicine and Rehabilitation
17. Plastic Surgery
18. Pulmonary Diseases
19. Radiology
20. Surgery (General)
21. Thoracic Surgery
22. Urology
23. Others (Hematology, Occupational Medicine, Physical Medicine, Public Health)

Not all these residencies are recognized medical specialties for which certificates are granted by examining and certifying boards. There are 19 specialty boards approved by the American Medical Association and the Advisory Board for Medical Specialties:

1. American Board of Anesthesiology
2. American Board of Colon and Rectal Surgery
3. American Board of Dermatology
4. American Board of Internal Medicine
5. American Board of Neurological Surgery
6. American Board of Obstetrics and Gynecology
7. American Board of Ophthalmology
8. American Board of Orthopaedic Surgery
9. American Board of Otolaryngology

10. American Board of Pathology
11. American Board of Pediatrics
12. American Board of Physical Medicine and Rehabilitation
13. American Board of Plastic Surgery
14. American Board of Preventive Medicine
15. American Board of Psychiatry and Neurology
16. American Board of Radiology
17. American Board of Surgery
18. Board of Thoracic Surgery
19. American Board of Urology

The American Medical Directory lists 35 recognized medical specialties, not all of which are either residencies or American Specialties:

1. Administrative Medicine
2. Allergy (sub-specialty of Internal Medicine)
3. Anesthesiology
4. Aviation Medicine (special field of Preventive Medicine)
5. Cardiovascular Disease (sub-specialty of Internal Medicine)
6. Child Psychiatry (sub-specialty of Psychiatry)
7. Colon and Rectal Surgery
8. Dermatology
9. Diagnostic Roentgenology (special field of Radiology)
10. Forensic Pathology (special field of Pathology)
11. Gastroenterology (sub-specialty of Internal Medicine)
12. General Practice
13. General Preventive Medicine (special field of Preventive Medicine)
14. General Surgery
15. Internal Medicine
16. Neurological Surgery
17. Neurology
18. Obstetrics and Gynecology
19. Occupational Medicine (special field of Preventive Medicine)
20. Ophthalmology
21. Orthopedic Surgery
22. Otolaryngology
23. Pathology
24. Pediatrics
25. Pediatric Allergy (sub-specialty of Pediatrics)

26. Pediatric Cardiology (sub-specialty of Pediatrics)
27. Physical Medicine and Rehabilitation
28. Plastic Surgery
29. Psychiatry
30. Public Health (special field of Preventive Medicine)
31. Pulmonary Diseases (sub-specialty of Internal Medicine)
32. Radiology
33. Therapeutic Radiology (special field of Radiology)
34. Thoracic Surgery
35. Urology

The American Board Specialties and the training residencies (excluding for the time being all other specialties) fall into seven categories. Figure 5 shows the relationships of these specialties to the health care process. This is a generalized diagram which only intends to illustrate the fact that medical specialties are somewhat process-oriented. The classification of specialists into groups is not a standard practice and should not be used for purposes other than understanding general relationships. It does serve to show that certain physicians are dominantly involved in first contacts with patients and that others serve a supporting, non-clinical, function in the process of health care.

The Medical Care Process

The usual procedure for patient care starts with an abnormal sign, symptom, or complaint from a patient. Figure 6 shows the process as it moves from the original patient confrontation to satisfactory response to therapy. Both dark and light arrows are used to illustrate the fact that the process is not rigidly fixed to a given sequence but can be modified by the particular ailment and the diagnostic acuity of the clinician. The process starts with the interview and then continues with a collection of data on patient history, an examination of the patient, various prescribed laboratory tests, test findings, a diagnosis, prognosis and therapy, and finally the patient's response to therapy.

A diagnosis can be differential, provisional or final, non-clinical (clinical laboratory or radiological), or can occur during a phase of a hospital admission or stay. A diagnosis is a medical opinion stated at the end of a step

TYPE OF SPECIALTY	PROCEDURE: INTERVIEW	HISTORY	PHYSICAL	TESTS	FINDINGS	DIAGNOSIS	THERAPY	RESPONSE
PATIENT	General Practice Pediatrics OB-GYN Aviation Medicine	→	→	→	→	→	→	→
SYSTEMIC						Internal Medicine Gastroenterology Cardiology Urology Psychiatry and Neurology Pulmonary Diseases	→	→
ANATOMICAL						Ophthalmology Otolaryngology Orthopedics	→	→
REACTION						Allergy Dermatology	→	→
SURGERY							General Surgery Colon & Rectal Surg. Orthopedic Surgery Thoracic Surgery Neurosurgery Plastic Surgery Physical Med. & Rehab.	→
NON-CLINICAL				Pathology Radiology	→	→	→	→
SPECIAL	Preventive Medicine						Anesthesiology	

Fig. 5 RELATIONSHIP OF SPECIALTIES TO THE HEALTH CARE PROCESS

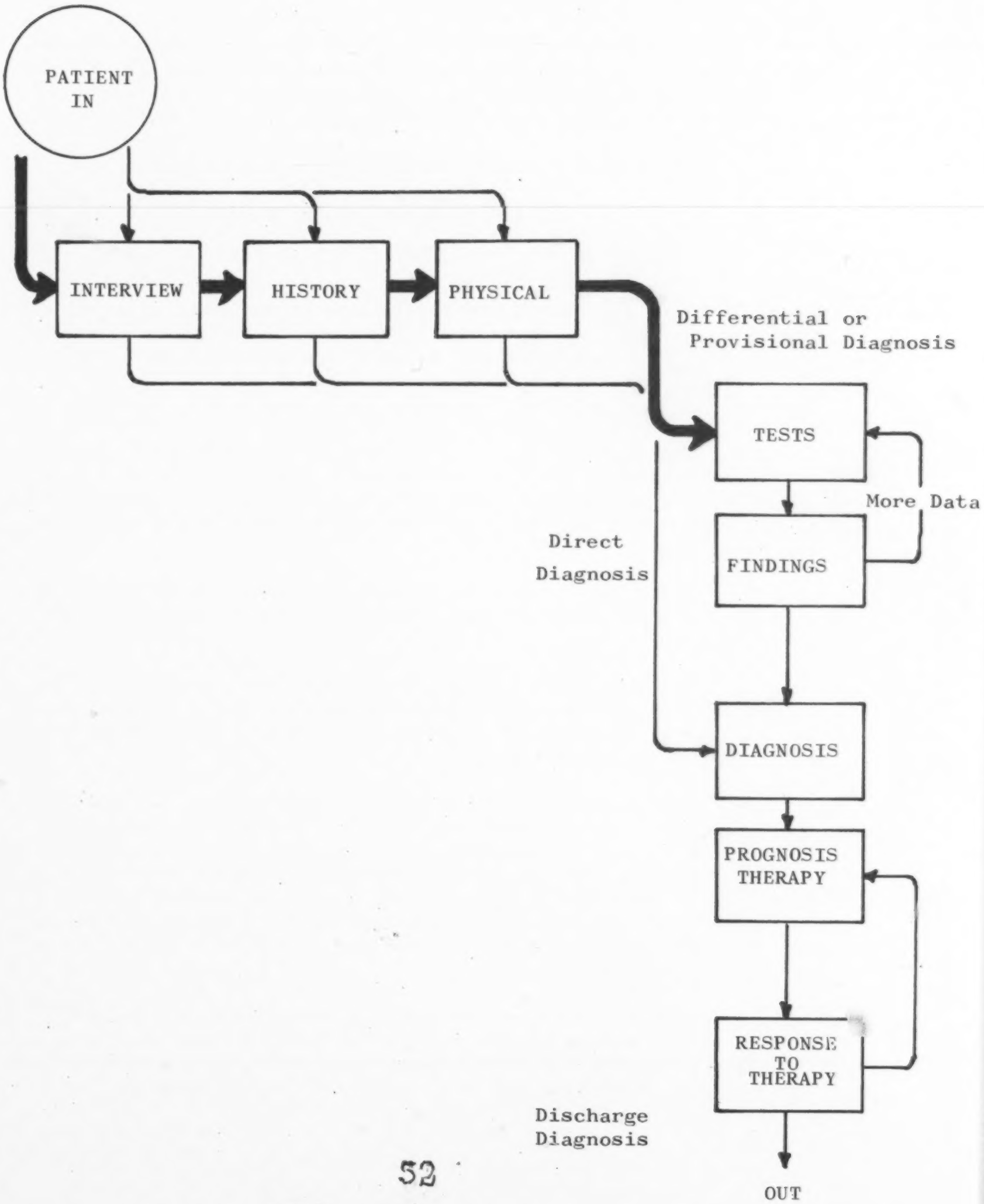


Fig. 6 THE MEDICAL CARE PROCESS

in the patient care process, by a generalist or specialist, and to the degree that symptoms and findings permit. It can be modified by patient response or by further tests.

The interview (or observation) is the first doctor-patient contact. In the case of a complaint, this is the first and one of the most important steps in the isolation of the cause for complaint.

The collection of patient history is a distinct step in the patient care procedure, although it may dovetail with the dialogue between the doctor and patient during the original interview. The interview and history are combined when the patient's personal and family history may have a bearing on the isolation of a medical problem.

The examination of a patient by the physician is the third distinct step in the patient care process. It is a procedure prescribed by academic medicine but modified considerably by the experience of the physician and the particular event in question.

Laboratory tests in search of supporting data supplement provisional diagnoses or indicate areas of abnormal body activity.

The diagnosis, prognosis, and therapy are the accumulated result of the steps taken up to this point. Finally, the patient's response to a therapy determines what course of action is to be taken next.

The physician cycles through this procedure depending upon the patient's response to therapy. If the diagnosis is correct and if the patient responds favorably, the procedure does not repeat. If the patient does not respond to therapy or if the diagnosis was provisional and an experiment with therapy was being made, the procedure cycles back to any of the preceding steps depending upon the physician's need for additional patient data.

Figure 7 shows the changes that can occur in the medical care process as the reason for patient care changes. The usual procedure is shown under the "curative" column. The numbers, depicting order of sequence, are listed in ascending order for the curative problem.

PROCEDURE	REASON FOR PATIENT VISIT					
	PREVENTIVE			CURATIVE		
	Routine Physical	Special Exams	Screening	Signs, Symptoms or Complaint	Emergency	Referral
A. Interview	2	2	3	1	→ 1 (Observation)	2
B. Patient History	1	1 (Review)	→ 1	2	4	1 (Revie
1. Personal and Demographic	↓	↓	↓	↓	↓	↓
2. Vital Statistics						
3. Personal History						
4. Family History						
C. Examination	3	3	4	3	→ 1	3
D. Tests	4	4	→ 1	4		4
E. Findings	5	5	2	5		5
F. Diagnosis	6	6	5	6	→ 1	6
G. Therapy-Prognosis			6	7	2	
H. Response to Therapy			7	8	3	

Fig. 7 CHANGES IN SEQUENCES OF CARE

The emergency curative problem starts with the initial observation, is followed by rapid examination and immediate diagnosis. Treatment precedes many of the usual medical amenities.

Screening examinations are typical of those conducted by Kaiser Permanente in Oakland, California. In this case, history and tests are conducted simultaneously and are followed up by an interview when findings are abnormal.

Both figures illustrate the involvement of the health care team in the process of medical care. The supporting team augments the patient/doctor relationship for non-clinical tests, health screening, patient preparation, and the like.

Physician Job Functions in the Care Process

The functions of a physician are modified by the type of practice, i.e., specialization, in which he is involved, and the organization to which he belongs. Health services and care programs that are available locally are secondary modifiers.

A pediatrician-psychiatrist, for example, would be involved in the function of parent counseling, whereas a radiologist would not be. A pediatrician solo practitioner would manage an office where a pediatrician in a large group practice would not. A pediatrician in Massachusetts, which offers free strep culture services, might not equip his office to perform cultures where a pediatrician in another area might.

Some of the principal job functions of physicians are discussed in further detail below:

1. Learning

   Discipline-oriented prior to certification. Mission-oriented after certification. Mandatory for pre-doctoral students. Mandatory for special certification. Optional after certification. Limited course attendance mandatory for American Academy of General Practice membership. Discussions of relicensing legislation often accompanied by requirement for mandatory education. Traditional courses in continuing

education favor practitioners in metropolitan and near metropolitan areas. Some rural practitioners, e.g., in Indiana, are able to take advantage of network benefits offered by state educational services. Hospital staff meetings are sometimes used as a learning environment.

2. Teaching

Accredited institutions of higher education dominate the field of laboratory and classroom teaching. Approximately three out of four institutions offer postgraduate or continuing education courses. Bedside teaching conducted in university and affiliated hospitals. Teaching function often coupled with research and clinical practice among the 20,000 full-time medical school faculties. Bedside teaching and clinical practice common with the 40,000 additional part-time faculty members. Teaching function is minimal in solo and group practices. Increases in the large clinics. Teaching function is very apparent in the Big Six clinics (Mayo, Cleveland, etc.)

3. Training

Internships and residencies are the training functions. These functions are assigned to the institution not the individual. All except two medical schools have intern and resident programs. 816 hospitals have intern programs. 1,455 hospitals have resident programs. Residencies are by specialty. A hospital staff physician may or may not be involved in the training function, depending upon the particular residencies for which that hospital is approved.

4. Preventive Medicine

This function includes periodic health exams, multiphasic screening, advice to the general public on health practices, and community health practices. Health screening is an institutional function. Physicians may become involved if the institution with which they

are affiliated, e.g., Kaiser, has established screening systems. Periodic health examinations performed by all practitioners at the option of the patient. Various regional programs are interested in performing this function vigorously.

5. Curative Medicine

Principal function of medical care. This function is modified by the organization. The practice of medicine can differ in solo practice, group practice (profit-sharing or non-profit-sharing), clinics (employee or partner), hospital (employee or affiliate), teaching hospital (employee, affiliate, or preceptor), federal-state hospital, medical school (full-time or part-time), or other institutions.

a. General Treatment

Practiced by all general practitioners and specialists who become involved in the initial patient contact but not by non-clinical specialists such as pathologists, radiologists, and anesthesiologists.

b. Emergency Treatment

A function of all physicians who are involved in initial patient contact. Can be modified by the institution with which the physician is affiliated. Can be the full-time and sole function of certain physicians.

c. Consultation

A broad function. Patient or physician initiated. Can be a function of staff meetings. Mayo Clinic diagnostic teams are deeply involved in this as a daily form of medical practice.

d. Non-Clinical Diagnosis and Treatment

Laboratories and radiology are dependent on facilities and equipment. Pathologists and radiologists are affiliated with health

care institutions or commercial organizations. Degree to which pathology gets involved in health care is sometimes determined by effectiveness of various hospital committees.

e. Special Treatment

Special treatment per se is usually not a function of the physician, but a prescription for special treatment is. Depends on the availability of special staffs and facilities. Includes extended or special care.

6. Growth and Development

Dominantly the function of the pediatrician. Current interest in special problems of youths. Perinatal studies tend to interest obstetricians in problems which influence growth and development.

7. Counseling

A specialty-related function. Patient counseling very common in obstetrics. Parent counseling common in mental retardation. Family counseling involved in mental health. In other specialties counseling is limited by availability of preventive information.

8. Habilitation and Rehabilitation

Not necessarily a medical function. Mostly education, physical therapy, and occupational therapy. In medicine the specialists most involved in this function are the orthopedist and the neurologist.

9. Facilities and Instrumentation

More a research and education function than a clinician's function. Clinician becomes involved when special facilities or instruments are required for clinical tasks. Participation in activities involving facilities and instrumentation is usually voluntary.

10. Office Management

A mandatory requirement in solo practice. Tends to diminish as the physician group becomes larger. Not a function of the institution-affiliated practitioner. In solo practice this function involves finance, personnel, purchasing, scheduling, and records maintenance. Taught in some British schools.

The Organization

The organizations of physicians range from solo practice, in which the physician is an independent medical practitioner affiliated with other physicians, health workers, and organizations by choice, to closed staff medical clinics, in which the physician can be a salaried partner-employee working as a key member of a large medical care team. The types of medical care organizations that lie between these extremes are so varied that it is said that no two hospitals or two group practices are alike.

Both elements of individual and cooperative enterprise coexist in present-day American medical society. Solo practices are surrounded by and dependent on the organized enterprise. Conversely, the hospital accommodates the individuality of the members of the medical staff.

The solo practitioner is independent up to the point where his capabilities and facilities can no longer accommodate the needs of his patients. He is dependent, in varying degrees on laboratories, hospitals, clinics, and convalescent homes. In one sense, the solo practitioner stands separate from these organizations and does exercise the option of dependence. In another sense, he is strongly dependent on the organization and must rely on an organizational team to make his efforts productive and effective.

The antithesis of the individual enterprise is the hospital. Figure 8 is a sample organization chart published by the American Hospital Organization.[3] It is used by the AHA

---

[3] Chart of Accounts for Hospitals, American Hospital Association, Chicago, Ill., 1966.

HOSPITAL ORGANIZATION CHART

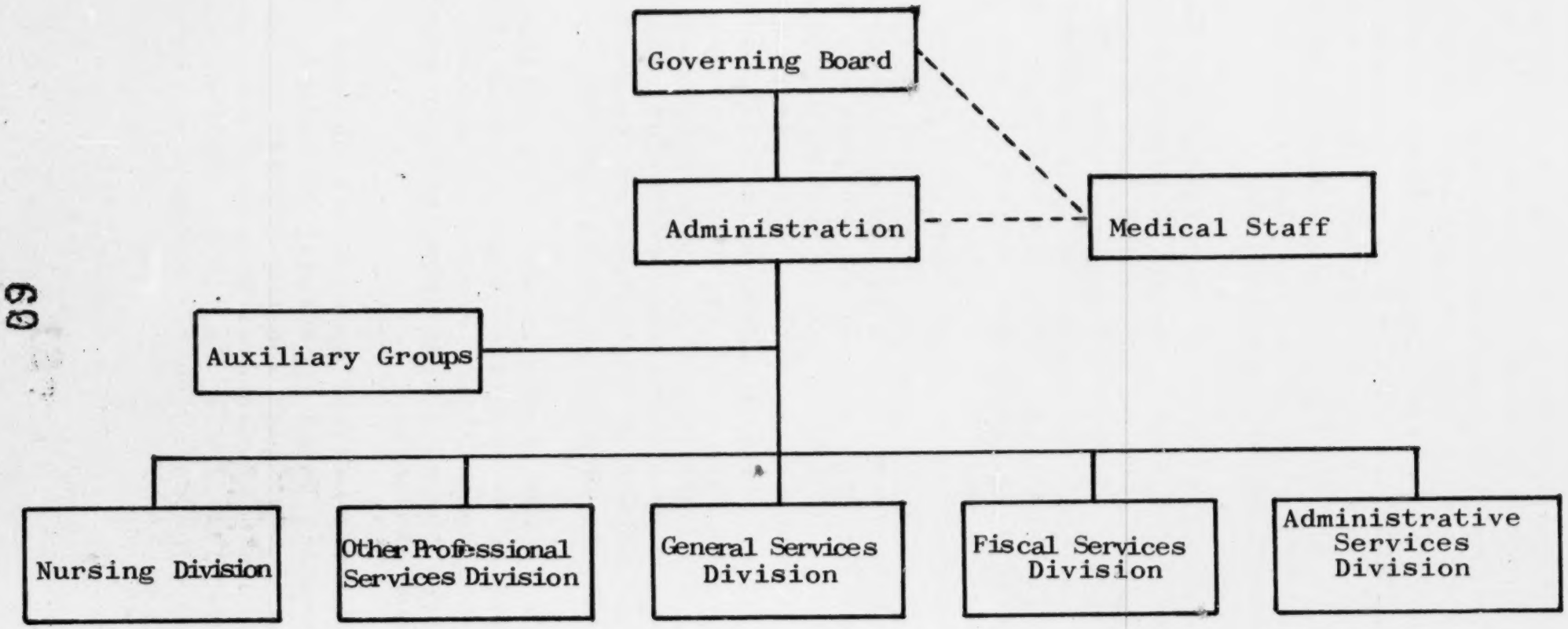


Fig. 8 AMERICAN HOSPITAL ASSOCIATION SAMPLE ORGANIZATION CHART

to establish the framework for a uniform chart of accounts for hospitals. The figure, showing five divisions of management, is accompanied by text which acknowledges the fact that management responsibility varies with individual hospitals and that hospitals vary widely in basic organizational structures. Organizational details are included in the publication for each of the operating divisions. No details are included for the medical staff. In this highly organized atmosphere the medical staff is treated as an entity practicing in but separate from the stricture of organization.

These examples, perhaps over-emphasized in isolation, will serve to point out that elements of organization exist in areas of private practice and conversely that elements of individuality exist in all forms of organization. There is reason to suspect that, except for degrees of individuality and organization, both will continue to exist and that some discussion of cooperative enterprise as it is now practiced, will be appropriate.

The interaction of physicians with others in medicine and health varies with the disease or ailment in question, the diagnostic and therapeutic course of the disease or ailment, the dependence of the practitioner on services not normally provided, and the practitioner's need for deeper experience in a narrow field. Interaction, either voluntary or by organizational dictate, is of interest because information used by the physician for medical care might be conveyed to him through these contacts. For this reason it is necessary to know what information conveyed to a particular colleague, allied professional, or medical worker at what stage of the medical care process is potentially beneficial to the patient.

Closest to the physician are those colleagues who, by virtue of training or practice, share similar clinical experiences. Barring competitive barriers of private practice, the physician gains the most from those who can expand his repertoire of case histories.

Next are the medical specialists on whom he is dependent for diagnostic depth or special therapies. Nurses and others closest to the patient and the bedside follow. Last are the workers indirectly involved with medical care or the processes upon which medical care is based. Excluded as partners in the medical care process are the workers on the periphery

of this imaginary circle, who are more involved in the operation and maintenance of the institution in which care is provided.

A discussion of some of the people involved in the medical care process will serve to illustrate how the interaction between patient-physician-and a third party changes with disease, with the stage of care, and the need for special services, and how information provided to the third party can be of benefit to the physician and the patient.

1. Physician-Physician

   Associations with like physicians is voluntary in private practice. Contact exposure via local society meetings and other opportunities. Contact within departments is routine for closed staff hospitals and clinics. Barriers to inter-departmental contact in organized institutions. Physician can obtain informal reactions to current cases. This is of particular value in diagnostic problems. Other physicians add to case history repertoire. Physician-to-resident contacts in teaching hospitals are said to be stimulating. Rural physicians are at a disadvantage on this type of interaction. Information is hearsay. Not necessarily bad because of training of physician, which teaches him to accept no one information input as inviolate.

2. Physician-Specialist

   Disease and medical care process type of contact. Disease-oriented physician-to-specialist links that are common and frequent often lead to a trend in physician sub-specialization, e.g., pediatrics cardiology, pediatrics psychiatry, and internal medicine psychiatry. Contacts are patient- and disease-related. Physician contacts with radiologists, pathologists and anesthesiologists occur during a phase of the medical care process. Communications from specialist to generalist (or initial contact physician) serve to advise the generalist of current capabilities of the specialist. Physician-specialist contacts

place a demand on the physician to be currently aware of the state-of-the-art of that specialty.

3. Physician-Nurse

Degree of contact varies with level of nursing skill and job assignment of nurse. Differs for practical nurse, registered nurse, nursing supervisor, or nursing specialist. Differs also for office nurse, floor nurse, maternity nurse, and visiting nurse. Physician must be aware of hospital standing orders and procedures which might affect his patient orders. Physician highly dependent on nurse to fill orders accurately. Nurse shares some legal liability on medication orders. Office nurse is employee of the physician in solo practice. Floor nurse is the employee of the hospital. Nurse contact hours with patients in hospitals much higher than physician contacts. Physician forced to be dependent on floor nurse for observation of patient. All patient-related nurse training has a direct impact on the physician. Educational materials for nurses include current medical awareness.

4. Physician-Pharmacist

Interactions between physician and pharmacist vary widely because of diverse occupational involvements of pharmacists. Not to be confused with physician contacts with pharmaceutical detailmen. Pharmacists may be hospital pharmacists, commercial pharmacists, surgical ward floor pharmacists, or employees of community pharmacies. All states have licensing requirements for the nation's 122,000 pharmacists. Pharmacists accumulate knowledge of a wide variety of medication experiences which supplement experiences of any one physician. Expanding variety of medication alternatives increases dependency of physician on the pharmacist.

5. Other Occupations

Specialized requirements for medical care of care-related situations result in interactions with various other occupations. In inner cities a community health center physician would interact closely with case workers and visiting nurses. On retrospective search problems, requiring study in depth, the physician interacts with the medical reference librarian. Orthodontics ties in closely with mental retardation and the pediatricians involved in that field. Mental retardation, because of habilitation requirements, causes closer interation between the pediatrician and the primary school teacher. The medical record pulls the records librarian into the physician environment. These are mission-oriented contacts.

The interactions of physician with physicians and other health personnel involved in medical care is one facet of communication that eventually benefits the patient. Not all contact lines extend from the physician to other persons. There are lateral interactions between allied professionals and others. The combinations are endless. It is this total establishment and the variety of interactions between people in the establishment that describes the overall cooperative enterprise of medical care.

VII. HEALTH CARE REQUIREMENTS FOR INFORMATION

Information in health care is here compared to a general information requirement, in order to illustrate the need for applied information in medical care. This illustration is based on anticipated or unanticipated requirements and excludes casual browsing not directed to satisfy a specific need.

Figure 9 lists the general characteristics of the two requirements. The first column describes a before-the-fact requirement for information that can be foreseen, motivated by an awareness of the value of continuing education, knowledge of deficiencies pointed out by peer or self-assessment, or the competitive demands of private enterprise. The second column describes an after-the-fact need for information that could not have been expected before the appearance of the problem.

"Anticipated areas of interest" is a general state of need, based on topical interest. The window of inquiry is broad, and the vocabulary of search may be generic rather than specific. Interest extends into other disciplines because of overlapping work being done in other subject areas. Reliance on processed materials, particularly those which include some selectivity, is high. Exhaustive and comprehensive searches are common, and the time required for response to an inquiry varies.

Preventive medicine and emergency problems in curative medicine tend tofall into this category. The former arrives at a general conclusion from an accumulation of many particulars and, perhaps for that reason, requires a steady input of information. The latter falls into this category for other reasons. There are known types of emergencies, and the actions of health care personnel can be specified beforehand. Predictable situations, rather than a need for general information, places this type of care into the category of a-priori needs.

Patient care situations, except for emergency requirements, are preceded by information searches based on anticipated needs and may then shift into the category of "unanticipated areas of interest". General trends and demands can be anticipated to a large degree, but new situations do

ANTICIPATED AREAS OF INTEREST	UNANTICIPATED AREAS OF INTEREST
A-PRIORI	POST-PRIORI
DISCIPLINE-ORIENTED	MISSION-ORIENTED
EXHAUSTIVE	EARLY CONFIDENT LEVEL OF YIELD
PROCESSED MATERIALS	ORIGINAL, EPHEMERA & PROCESSED MATERIALS
TIME REQUIREMENT VARIES	TIME-CONSTRAINED
BROAD INQUIRY WINDOW	DEPENDENT ON PEER EXPERIENCE
	MORE THAN ONE SOURCE REQUIRED
	LEVEL-BY-LEVEL
	NARROW INQUIRY WINDOW

Fig.9 MODES OF INFORMATION UTILIZATION

not always follow these trends, nor do signs and symptoms of distress always appear in fixed combinations.

The "unanticipated area of interest" category is typical for a physician confronted with a patient with a diagnostically obscure ailment, or with an obvious ailment that does not, however, respond to therapy. This situation imposes a clinical demand for information which is time-constrained because of the low waiting tolerance of both physician and patient. Promptness is dictated by the fact that early interference with the course of an ailment is preferred.

This demand is a level-by-level search, one level of information at a time, terminating at a point determined by the physician. A level of search can be represented as a set of concentric circles with the physician and patient at the center, the most closely related clinical experiences at the first level, and the most distantly related animal or basic research at the outer periphery.

The physician is not concerned with information handling problems or with the practical difficulties of handling ephemera. Original, surrogate, ephemera, and processed materials may be used, and those near the inner physician-patient circle, which involve applied and clinical experiences, are favored. Physicians are not necessarily more confident of information appearing in medical journals, and sometimes prefer to correlate one source of information with another, regardless of the greater traditional validity of one source over another. Opinions and interpretations of information by colleagues and allies can facilitate the problem-solving process.

The clinically related information problem is at variance with general search problems in that physicians do not always use tree structures of morphological word branchings to extend their searches to the farthest limits. He stops at a level determined by the relationship of the answer to the problem where the problem is described to him by his dialogue with the patient.

The baseline of the clinical information problem is the record of patient medical events. The medical record is the written document which comes closest to the physician's point of departure for information. The health care process describes the point in time and loose boundaries of the search.

In addition to being a record of care rendered to a patient, the record is a quality control instrument, a referral for legal disputes, the basis of an accounting record, a research tool, a teaching device, and, in the problem-solving sense, an extended history which places causes and effects in closer context.

Finally, the medical record constitutes one of the few mechanisms that can be used to evaluate the effectiveness of medical and health care programs.

Figure 10 shows the component sections of the medical record. It is sub-divided into the "direct record", the "other direct record" and the "indirect record" to differentiate between records of actual medical care vs. the business, management, and legal aspects of health care.

The "direct record" is that portion concerned with the medical care process. Departmental and specialty sub-sets are shown separately to accommodate the wide range of observations and data that are collected by the various individuals involved in the care process. The "other direct record" contains legal authorizations, doctors' orders, test procedures, and all other data of casual interest to the clinician. The "indirect record" is the section containing administrative and other data peripheral to direct care.

The "direct record" is the start of the problem-solving trail. If the record is current, complete, available, and well organized medically, it can link cause and effect. The questions that arise during the physician-patient dialogue contain the elements of search for information, the need for which was not previously anticipated.

Basic educational and reference materials constitute the next level. These materials are often those books, references, package inserts, and compendia owned by (and therefore immediately available to) the physician. They may also include library materials; this depends upon the size, availability, and services rendered by the nearest medical library. The wide variation in the size of library collections and the staff available to provide services affects to a very great degree the search interest and tenacity of a physician at this level.

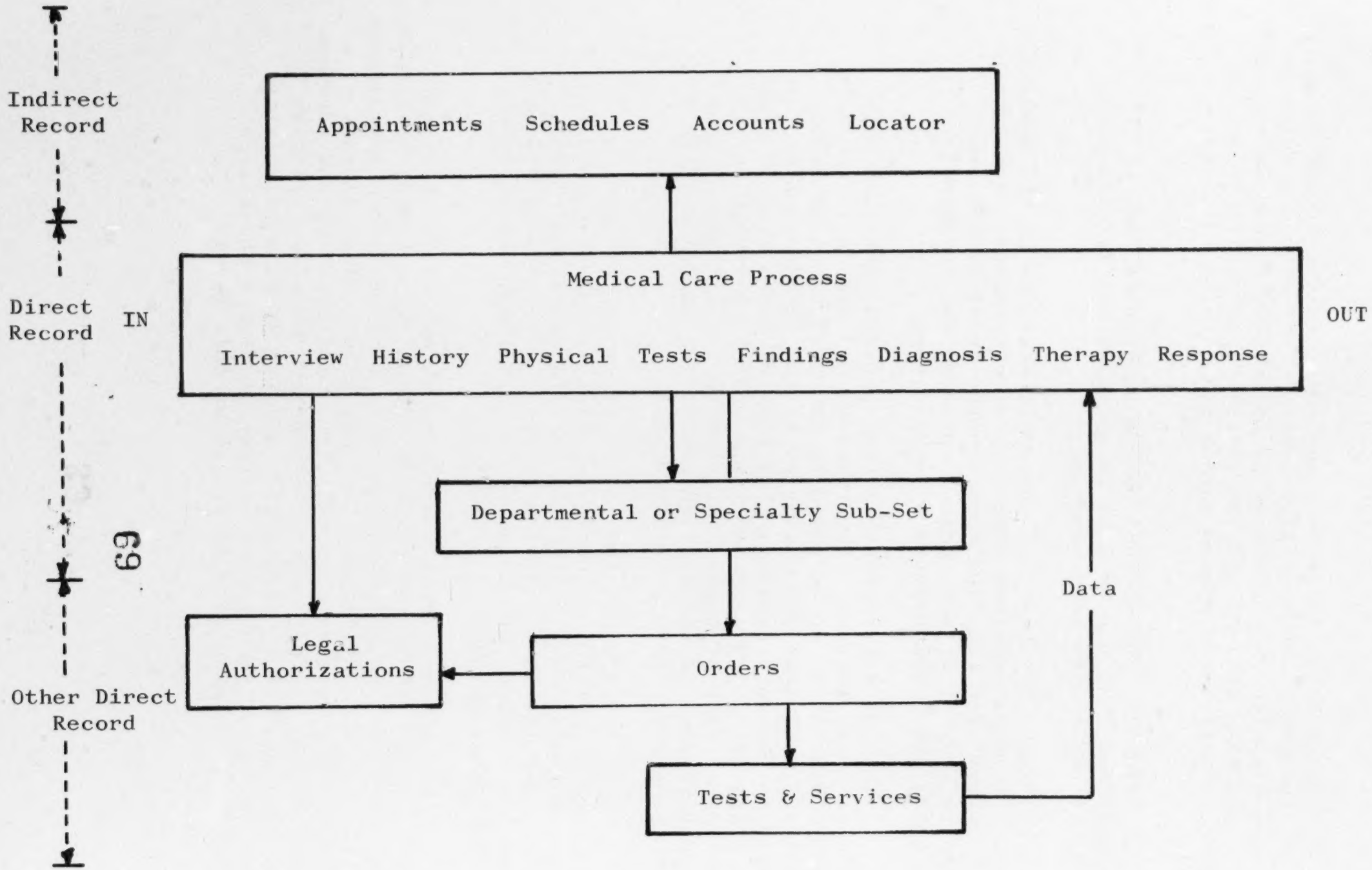


Fig.10 THREE SECTIONS OF THE MEDICAL RECORD

Other materials at this level are references, texts, inserts, bulletins, and trade journals not normally handled by medical record or medical library groups but which very often form an important part of the physician's (or an allied worker's) personal library. This category includes personal guide materials used by reference librarians who are assisting readers in the search for materials.

Other medical records or clues to the existence of such records are at the third level. Case histories may include those stored by the medical record library or those reported in society journals. The keys to this level of information are the disease indexes maintained by each medical record library.

In time, the physician becomes progressively removed from the direct utility (to his patient) of retrieved information. At the fourth level, disease registries and statistical summaries are surrogate sources of information.

From the fifth level on, information is exclusively available in the processed literature. It consists of reports of clinical experiments on humans, applied research directly applicable to human processes, and, lastly, research conducted on animals or other non-human research.

Figure11 shows two of the ways that information is used. Information clusters for anticipated and unanticipated areas of interest are shown.

The flow of solid arrows from original materials to processed materials is indicative of how the step-by-step author-to-publisher-to-reader process is organized. The dotted arrows leading to ephemera show that the author and publisher are in one corporate enclosure and that, for proprietary or other reasons, sometimes not very much is known about the source or the validity of ephemera information.

The cluster on the left can be illustrated by the floor pharmacy of a hospital. The necessary information ingredients for direct care, in this case, are the medication record and information materials provided by manufacturers of the various drug products. These are supplemented by pharmacopeia, formularies, drug indexes, handbooks, and selected

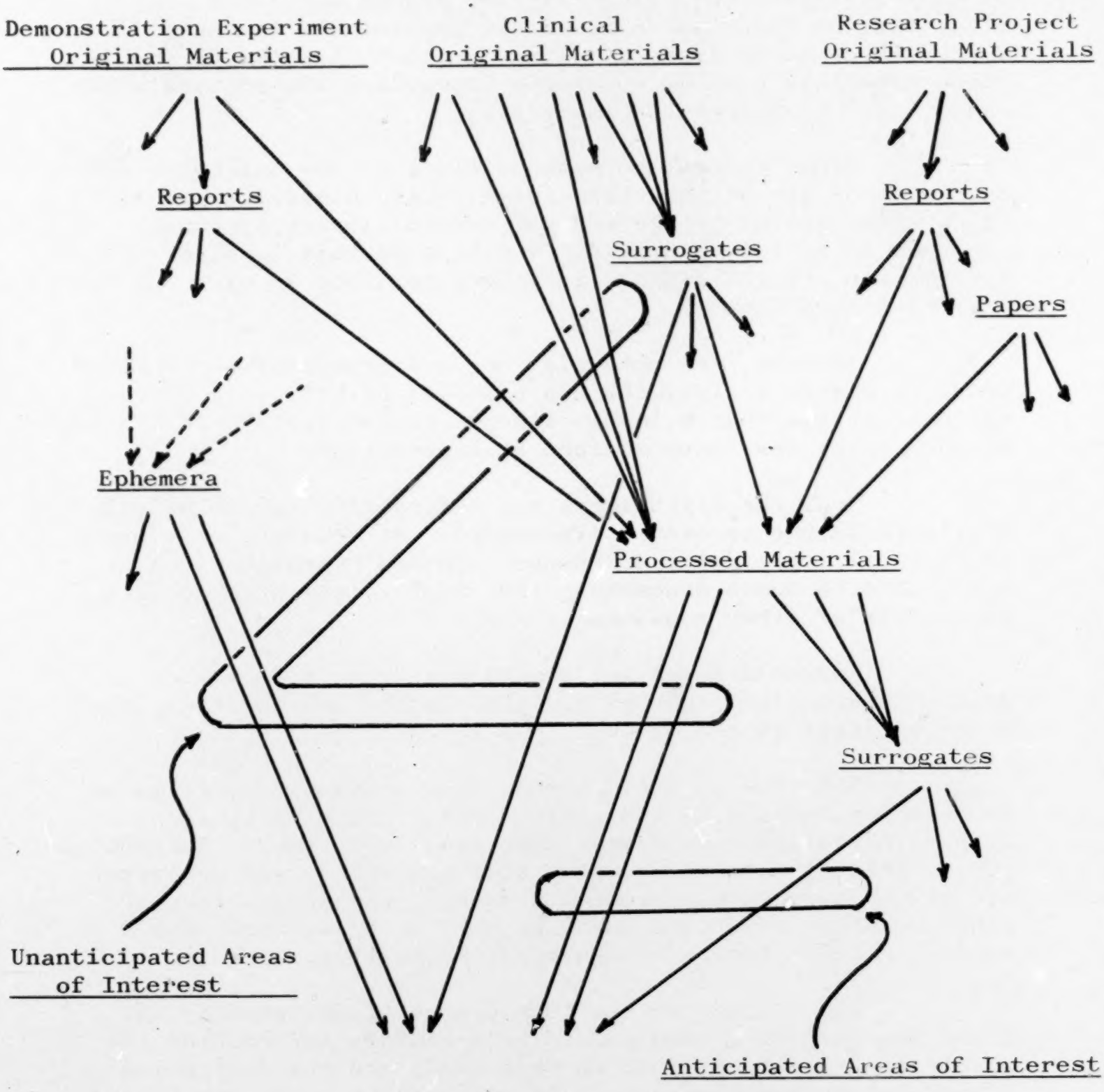


Fig. 11 INFORMATION COMBINATIONS

citations. The grouping of information in such combinations is typical of the way in which searches for information are conducted after a problem arises.

The clustering on the right, encircling processed materials and their surrogates, illustrates prevailing methods of working with library materials. It is characteristic both of the reference librarian and of the user looking for retrospective materials.

To a certain degree these clusters of materials-in-combination are encouraged in medical records sections of hospitals that do not have a medical library or trained reference personnel. The records sections already have the hospital medical records, which are indexed according to the Standard Nomenclature of Diseases and Operations (SNDO), the International Classification of Diseases, Adapted for Use in the United States (ICDA), or other disease indexes. Lists of core reference materials have been prepared for them by such organizations as the National Library of Medicine and other medical school libraries. They also have access to many of the ephemera which are sometimes not maintained by reference libraries.

By consolidating these materials or developing directories and indexes to help find them, the records section, from a material viewpoint, would have a good part of the capability of a service point library for hospital and clinical personnel. There are indications that this approach to the development of medical library networks may be preferable to some attempts that are being made to develop satellite reference libraries in environments hostile to them.

VIII. BCN COMPONENTS FOR INFORMATION HANDLING

The organizational components of the Biomedical Communications Network, as described in the Technical Development Plan of the National Library of Medicine, dated June 1968, are:

1. The Library Component
2. The Specialized Information Services Component
3. The Specialized Education Services Component
4. The Audio and Audio-visual Component
5. The Data-Processing and Data-Transmission Facilities Support Component

Figure 12 is a diagrammatic representation of these five components. Both rectangles and circles are used for easy visualization.

The traditional library universe of printed materials and the surrogate services which support these materials is the larger rectangle. Data-processing and data-transmission support is the smaller rectangle contained wholly within the library universe. The complement of the smaller rectangle includes the functions of the library which do not lend themselves to computer automation or data communication. The intellectual process of acquisition is an example of a data-processing complement. Accessions listing, which is the product of acquisitions, is an example of a task that can be performed by data-processing methods.

The Specialized Information Services, Specialized Education Services, and Audio and Audio-visual Components are depicted as three intersecting circles which extend beyond the library universe. These are organizational components handling special collections.

The activities of the National Medical Audio-visual Center, Atlanta, Georgia, will serve to illustrate the relationships of the three circles and the library universe. Referring to the Audio and Audio-visual circle, the preparation of catalogs and guides, acquisition of visual materials, and the lending of these materials are normal to the library universe except that the materials are not similar to the printed materials of libraries. The graphic and photographic arts and the motion picture and television production programs of

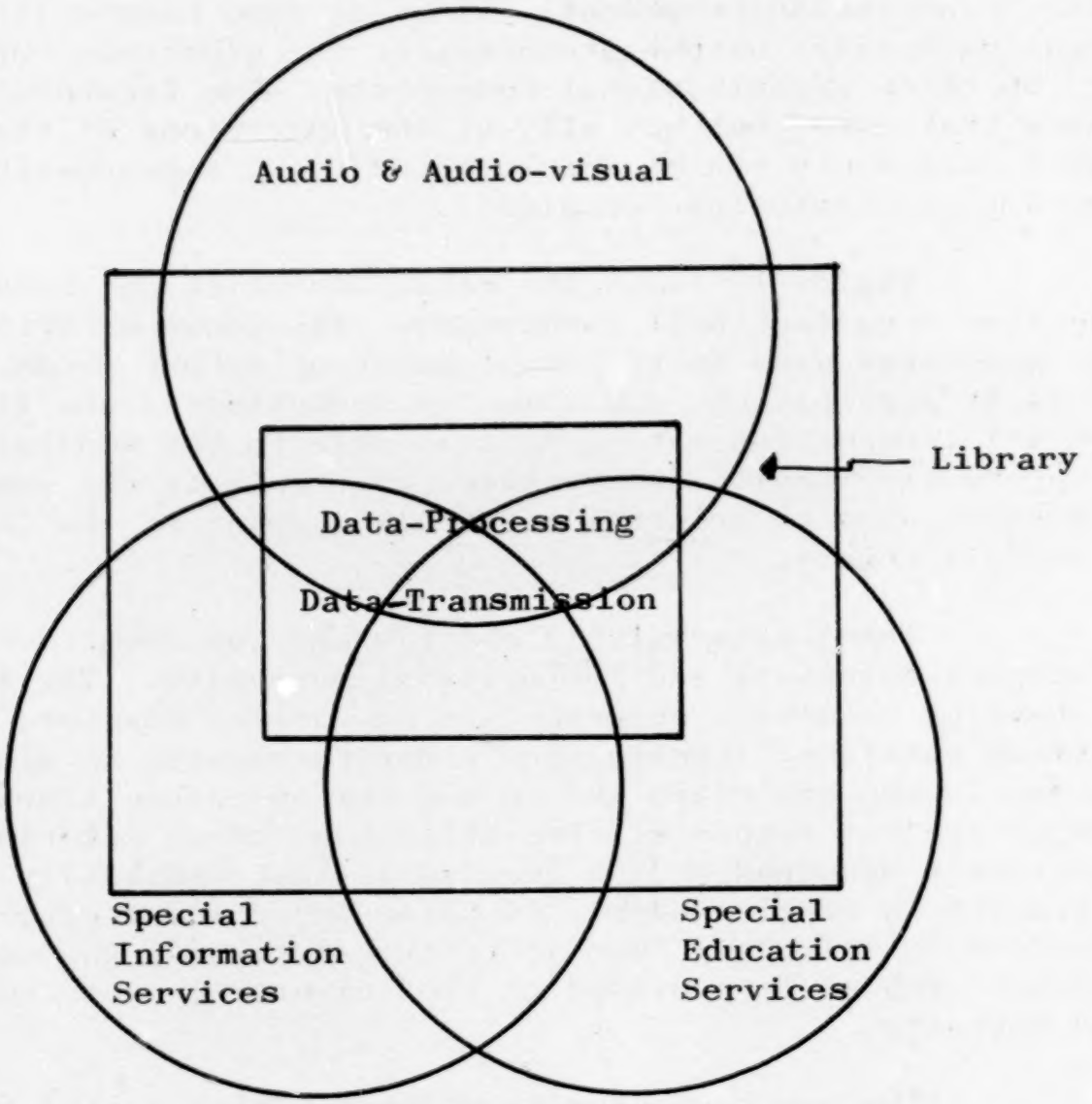


Fig. 12 ORGANIZATIONAL COMPONENTS OF INFORMATION MATERIALS HANDLING

NMAC are examples of activities that normally fall outside of the traditional library universe.

All three circles intersect and the common intersection of all three overlap with the data-processing and data-transmission component. There is some commonality of input materials, output products, or the processes employed by the three organizational components. The figure also shows that some, but not all, of the operations of these three components can be supplemented by data-processing methods and data-transmission techniques.

Figure 13 lists the materials which are handled in the five organizational components. The input materials, the processes used in the development of output products, areas of application, and some new technologies are listed. Not all information materials available to the medical and comprehensive health communities, particularly the ephemera and surrogates to original materials, appear in the input materials column.

Input materials in the Library Component are processed materials and not original materials. The library processing sequence, described in an earlier chapter, yields various catalogs, indexes, and other surrogates to aid the reader locate materials and to aid the reference librarian answer subject requests. The utility of these materials, previously hampered by the geographic inaccessibility of libraries to rural readers, is being increased through vigorous interlibrary loan activity and 24-hour photocopy service such as is provided by the Universities of Indiana and Nebraska.

The new technologies which may play a role in improving processing functions or enhancing reader service are:

1. Book handling techniques to speed up shelving and reduce delivery time.

2. Microfilms and microfiche to increase storage capacity and to permit the establishment of traveling libraries without service institutions.

3. Facsimile transmission to speed up interlibrary loan activity.

4. Remote viewing to permit remote browsing.

5. Automatic indexing to increase the capacity of staff-limited libraries.

COMPONENT	MATERIALS Input	MATERIALS Output	PROCESSING	APPLICATION	NEW TECHNOLOGY
Library	Books Monographs Periodicals Serials Abstracts	Catalogs Indexes Bibliographies Abstracts	Acquisition Accession Listing Indexing Cataloging Bibliographic Listing Reference Service	Reference Current Awareness Education Retrospective Search	Materials Handling Micro Forms Facsimile Transmission Remote Viewing Automatic Indexing
SIS	Toxicological Data Drug Efficacy References Experience Abstracts Registries Poison Control Data	Citations Bibliographies	Data Collection Indexing Search	Problem-Solving Answer Services	Time-Sharing Computers Voice Answer Back
SES	A—AV Materials Programmed Instruction CAI Programs Seminars Courses	Catalogs Directories ETV—CCTV	Acquisition Review Cataloging	Instruction Training Continuing Education	Computer Aided Instruction Programmed Instruction Education Techniques Two-Way Communications
A—AV	Motion Pictures Slides Film Loops and Strips Videotape Kinescope	Catalogs Indexes Sequence Indexes Guides Directories	Production Preservation Conversion Distribution Indexing Sequence Indexing	Education Public Information Current Awareness Training	Data Compaction Black TV Utilization Tone Decoders Speech Compression
DP—DT	Subject Headings Indexed Citations Special Information Control Data	Indexes Bibliographies Directories	Storage Retrieval	Problem-Solving Current Awareness	Computers Typesetting

Fig. 13 BCN INFORMATION RELATIONSHIPS AND APPLICATIONS

Specialized Information Services input materials include toxicological data, drug efficacy information, registries of various types, poison control data, clinical experience abstracts and references such as the United States Pharmacopeia, American Hospital Formulary, Drug Products Information File, handbooks, and indexes. This is a combination of surrogates to original materials, self-standing surrogates to processed materials, and related references and handbooks. These are materials often used in combination to meet the requirements of problem-solving and providing answers to specific clinical inquiries.

This list of input materials differs from the three input materials listed for the Specialized Information Services Component in the Technical Development Plan. The list was expanded to be more responsive to certain clinical inquiries.

This organizational component intersects with the Data-Processing Component in that these data are to a considerable extent computer-based. It also intersects with the Library Component in that the output materials of this component become standard library materials for the use of reference librarians and readers.

Two new technologies associated with the Specialized Information Services Component are:

1. Time-sharing computer networks to meet the time-constrained requirements of clinical inquiries.

2. Voice answer back systems to permit computer access by telephone.

The Specialized Education Services Component intersects with the Audio and Audio-visual Component in that some of the materials indexed and cataloged in the AV Component are input materials for education. In addition to these materials, inputs to Special Education Services include programmed instruction materials, computer-aided instruction programs, and listings and announcements of seminars, courses, training sessions, and rounds open to accredited members of the community. The catalogs of audio-visual materials are the products of the processing effort conducted in the Audio and Audio-visual Component. The directories are lists and compendia of the locations, activities, and resources of special groups known as learning resource centers, educational materials groups, or the equivalent.

ETV and CCTV or other wideband communications systems are listed to accommodate the possibility that some national programs in continuing education might be beamed from a network center.

The three principal applications of this component are instruction, training, and postgraduate or continuing education. Instruction is first- and second-year medical school teaching assistance for students, technicians, technologists, and allied professionals. Training for the medical student is augmentation of case histories which may include the total ecology of the patient. Training for the nurse includes information such as surgical set-up procedures. Continuing education is the vast continuum of the postdoctoral period for the physician, the dentist, the pharmacologist, and others involved in research, education, and service in medicine and comprehensive health.

Among the new technologies which might be used to augment these services are:

1. Computer-aided instruction and programmed instruction to be used for and by physicians, allied health personnel, and patients.

2. Various educational methods and techniques to improve the learning ability of students and trainees.

3. Two-way communications of various types to permit remote student/instructor dialogue.

The Audio and Audio-visual Component is the subject of a separate report dealing exclusively with the history, problems, and trends of learning resources as they are and might be used in the health sciences.[1] The input materials include all types and variations of audio and visual materials. Processing includes the preservation of materials for archival storage, conversion of materials to other formats, and possibly sequence indexing for motion picture films and videotapes.

---

[1] Cooper, William, Role of Audio and Audio-Visual Materials in Enhancing the Learning Process of Health Science Personnel. Report prepared for the University of Pittsburgh/EDUCOM in connection with NIH Contract PH 43-67-1152, January 1969.

Conversion of material from one format to another is not a common processing function although this is one of the solutions to the problem of playback or projection equipment incompatibility. The Network for Continuing Education in New York converted videotape from one format to another to match the expensive playback equipment of its various users. The University of Colorado Office of Learning Resources, in one known instance, converted 2" x 2" color plates of spinal cross-sections into 35 mm. cartridge format. This function is included in anticipation of the fact that an increasing number of production and distribution groups will grapple with conversion problems if playback equipment compatibility standards are not established.

Sequence indexing is also included despite the fact that this also is not a common processing function. Sequence indexing is dominantly a problem of motion pictures and videotapes where access to a portion of the film or tape is required. One technique developed by Ogi[2] involved the automatic sampling of visual clips of films at an abstract ratio of 400:1 and the mounting of 20 clips on an index (aperture) card. As the result of the visual indexing system, film loans dropped by 25%, although the number of cases of reprinting films remained the same.

The overlap between the Special Education Service Component and the Audio and Audio-visual Component is illustrated again by the similarity in applications. Audio and audio-visual materials are used for education, public information, current awareness, and training.

Four new technologies are listed for this component:

1. Data compaction to allow the transmission of visual materials at speeds or costs less than normal.

2. Black TV utilization to take advantage of intermittent pauses between sequences in television.

---

[2] Ogi, Masaaki, "Pattern Matching Technique Applied to Indexing and Retrieving Films for Television Use", Japan Broadcasting Corporation, Tokyo.

3. Tone decoders to allow touch tone telephone entry into central audiotape systems.

4. Speech compression to minimize queueing in central audiotape systems.

The Data-Processing and Data-Transmission Facilities Support Component receives input materials from the other four organizational components. The processed materials and various surrogates are handled by the other organizations and the indexes, bibliographies, and directories to these materials are developed by this component.

Storage and retrieval of selected portions of these indexes are the main processing functions. Problem-solving and current awareness are the principal applications.

The new technologies include:

1. Computer technology, in general, for the purpose of increasing storage capacity, increasing accessibility, and minimizing equipment dependency.

2. Automatic typesetting advances, in general, to permit increased utility of directories, references, and other surrogates.

IX. SUMMARY

In the introduction to this report, the bare requirements for a biomedical communications network were listed as the first step toward a detailed specification. This section will clarify or modify those initial statements based on the contents of this report. These items are still general requirements and must be further clarified even before a functional organization of tasks for an operating network can be described.

1. The biomedical communications system shall be a mission-oriented information system.

   Pre-doctoral students are primarily topic-oriented. The first independent exposure to care-orientation is after award of doctorate. In clinical practice, the physician's care-orientation is influenced by medical specialty. Generalists, pediatricians, obstetricians, gynecologists, and broad specialists exposed to initial contact with the patient are more involved in the broad influences of patient affairs. The researcher is research mission-oriented. This orientation leads him into other, topic but not necessarily care-related, areas of interest. The educator is topic and care-oriented. Restricted, topical dialogue with students, combined with medical specialty, can limit the educator to a narrow view of care-orientation.

2. It shall be accessible to all members of the medical and health community without financial penalty.

   Providing medical care is expensive. Although some effective curbs against rising costs are showing some signs of promise, there is no reason to believe that there will be immediate relief in this area. Information systems shall not increase this financial burden unless an obvious and measurable benefit accompanies this burden. Penalty includes staffing. At the present time, allied and supporting occupations in medicine and health

outnumber the physician by approximately 10 to 1 and yet staff shortages in medical service are acute. Requiring additional staff for information support in institutions directly concerned with medical service will detract from the mainstream of effort unless that effort is part of a natural, unmet requirement of those individuals.

3. It shall be responsive within the time constraints of the user.

   Time constraints in medical care, particularly during physician-patient confrontation, are critical. Physician and patient have low tolerance for long waiting periods. Time constraints are most pressing in unanticipated information situations. This implies that community hospitals will have to have a core information reservoir. NLM has prepared lists of recommended materials for reference libraries. Other core material lists will be required including non-traditional information materials.

4. It shall be addressable in the natural language of the user.

   Disease and operations indexes of medical records or the disease terminology used by the physician for record entry are the clinician's primary exposure to formal classification systems. Diseases and operations and sub-headings of signs and symptoms are used in context with the patient care process. The disease index and the care process form a coordinate index. Medical Subject Headings (MESH), by contrast, does not always have the patient care coordinate. Process descriptors such as diagnosis and therapy are added to MESH as sub-headings.

5. Applied as well as research information shall be included in the data file.

   Research information is dominantly processed information and the surrogates to these. Research information is sometimes on the remote periphery of information needed by a physician for patient care. Information in various combinations and registries and ephemera, are

often used in medical care to fill the void between available, processed information and clinical requirements.

6. The system shall accommodate, at least by catalog or index, all media of storage.

   Audio-visual materials are processed in much the same manner as ephemera. Editorial screens will probably be required before the material is cataloged. The process of indexing will require handling and viewing the material. Even with these safeguards, the cost of use will be high. Audio-visual material costs that can be amortized over a long period of time or a large audience will be more attractive to the subscriber.

7. The system shall include a directory to sources of information as well as a collection of materials and resources.

   There are numerous research centers, special information analysis centers, child study centers, and other demonstration and experimentation facilities in medicine and health. All facilities are potential sources for information or special consultations. In this aspect, the network resembles a large matrix at the intersections of which are numerous quasi-independent resources. A directory of services and information sources might be the first step toward a machine-controlled, switching network.

8. Data collection of significant statistics shall be part of the system responsibility.

   Little is known about medical care despite the surfeit of statistics and those statistics that are available are often inaccurate. As resource and service points in the network are established, population data should be collected and information request tallies by individuals should be maintained. In those cases where information is lacking, certain data collection efforts should be initiated, i.e., locations and identifications of resource material.

9. System effectiveness shall be determined by increase in quantity or effectiveness of patient care.

   Information for medical care can only be measured in terms of the quantity or quality of care offered. Dr. Thomas Meyer's study of physician practice deficiencies is one method of determining information needs vs. wants. If deficiencies are noted in a physician's knowledge and if his practice is dominated by that requirement, it can be assumed that formalized teaching will fill a void for that physician. Self-assessment tests serve the same purpose. Ultimately, the after-the-fact information needs of physicians should be measured from the medical record and an audit of diagnoses and prescribed treatments.

10. System implementation shall be effected by phases so as to insure application of results gained from experimentation, demonstration, and other such early phases of implementation.

    Satisfying unanticipated information needs for medical care is, at best, an area of speculation. Peterson's study was one of the earlier indications that clinicians followed many informal channels to information. Whether or not these channels can be formalized without sacrifice in time and with an increase in value is to be determined. Carefully controlled demonstration programs for information delivery in clinical situations should be able to determine what types of information are best delivered under what circumstances. Deterministic design criteria, such as these, are difficult to include in a system design specification.